ELECTRICAL MACHINES-I

LABORATORY MANUAL

DEPARTMENT OF
ELECTRICAL ENGINEERING

Rajiv Gandhi University of Knowledge Technologies

Basar– 504107

ELECTRICAL TECHNOLOGY LABORATORY

SAFETY RULES

1. Do not touch any terminals (or) Switch without ensuring that it is dead.
2. Wearing shoes with rubber sole is desirable.
3. Use a fuse wire of proper rating.
4. Use sufficient long connecting leads rather than joining two or there small ones, because in case any joint is open it could be dangerous.
5. Make sure that all the electrical connections are correct before switching on any circuit. Wrong connections may cause large amount of current which results damage of equipment.
6. The circuit should be de-energized while changing any connection.
7. In case of emergency or fire switch-off the master switch on the main panel board.
8. Keep away from all the moving parts as for as possible.
9. Do not renew a blown fuse until you are satisfied to the cause and rectified problem.
10. Do not touch an electric circuit when your hands are wet or bleeding from a cut.
11. Do not disconnect plug by pulling a flexing cable when the switch is on.
12. Do not throw water on live electrical equipment in case of fire.
13. Do not test the circuit with bear fingers.
14. Do not use loose garments while working in Laboratory.
15. Do not open (or) close a switch (or) fuse slowly or hesitatingly. Do it quickly and positively.

Electrical Machines-I Lab Report Format

Aim of the Experiment:

Apparatus Required:

S.No	Equipment Name	Range	Type	Quantity
1	Voltmeter	(0-300)V	MI	2No's
2	Wattmeter	5A,300V	Electrodynamometer type	2No's
3				

Name plate details:

Theory:

Circuit diagram:

Procedure:

Expected Results (if applicable):

Experimental Results:

1. Observation Tables:
2. Sample Calculations:
3. Graphs (if applicable):

Conclusions:

Discussions: (To be written individually by a student)

EE2701 ELECTRICAL MACHINES-I LAB

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **0-0-3-2**

Course Objective:

- To expose the students to the operation of DC machines, transformers and give them experimental skills.

Course Outcomes: Upon completion of the course the student will be able to

- Analyze the characteristics of DC machines and transformers
- Perform tests on DC Machines and transformer and evaluate their performance

Any Ten of the following Experiments:

1. To obtain magnetization characteristics of a d.c. shunt generator.
2. To obtain load characteristics of a d.c. shunt generator and compound generator.
3. To obtain efficiency of a dc shunt machine using Swinburn's test.
4. To perform Hopkinson's test and determine losses and efficiency of DC machine.
5. To obtain speed-torque characteristics of a dc shunt motor.
6. To obtain speed control of dc shunt motor using

   (a) Armature resistance control (b) Field control
7. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.
8. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
9. Load test on dc series generator.
10. Field's test.
11. Polarity and ratio test of single phase transformers.

1. MAGNETIZATION CHARACTERISTICS OF DC. SHUNT GENERATOR

Aim:-

To determine the magnetization characteristic (O.C.C) of the given DC shunt Generator and to find out the critical field resistance and critical speed.

Apparatus Required:-

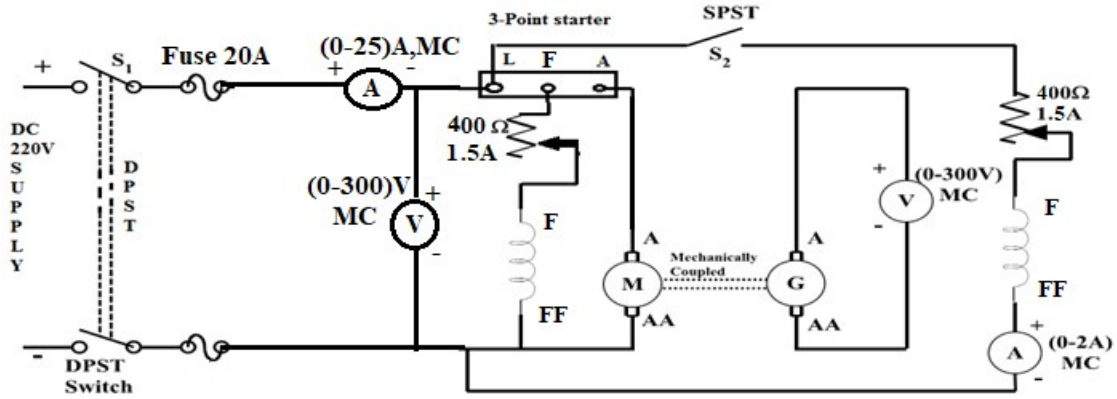
S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0 - 300)V	MC	2NO
2	Ammeter	(0 – 2.5)A	MC	1NO
3	Rheostat	400Ω, 1.2A	Wire wound	2NO
4	Tachometer	(0-10,000)rpm	Digital	1NO
5	Connecting wires	(0-20)A	-	Required

Name plate details:-

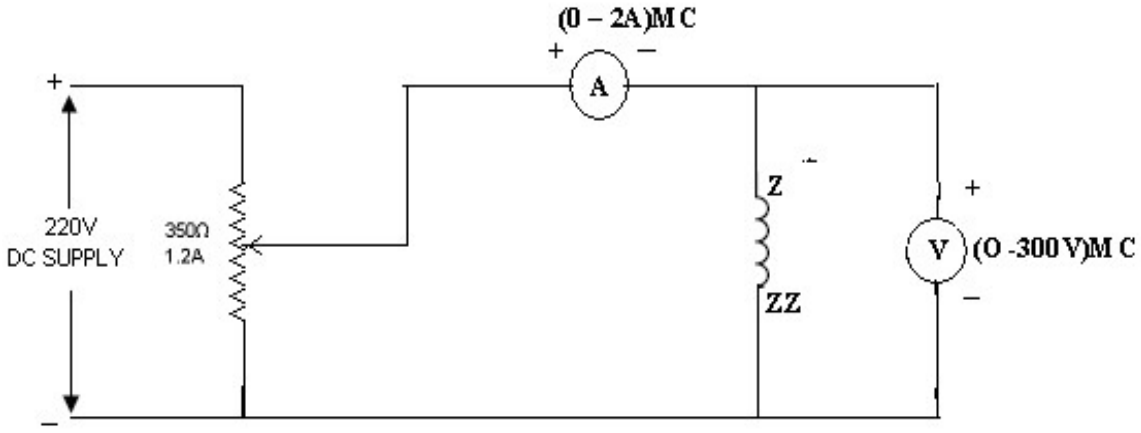
Motor	**Generator**
Voltage - 220V	Voltage - 220V
Current -19A	Current -13.6A
Speed - 1500 rpm	Speed - 1500 rpm
Power - 5HP	Power - 3KW
Excitation type –shunt	Excitation type - shunt

Circuit diagram:-

Circuit diagram for OCC :



Circuit diagram for finding field resistance:



Theory:

----To be written---

Procedure:

1. Make the connections as per the circuit diagram.
2. Initially keep the motor field rheostat in minimum resistance position and Generator field rheostat maximum resistance position.
3. Give the supply by closing DPST switch and start the motor with the help of 3- point starter.

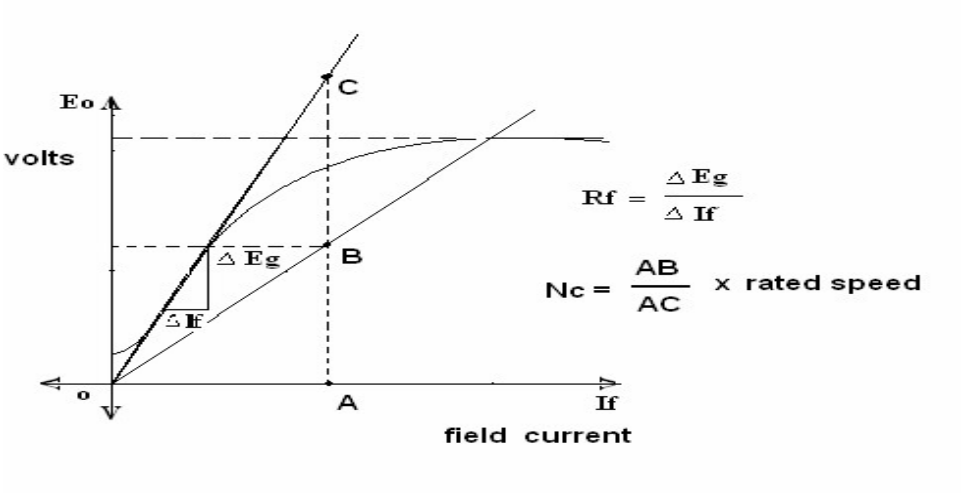
4. Adjust the motor field rheostat till the rated speed is obtained.
5. Give the supply to the generator circuit.
6. Vary the generator field rheostat in steps to get field current and measure open circuit voltage at each step.
7. Repeat step no. 6 till we get 120% of rated voltage.
8. Decrease the field current in steps and note down the open circuit voltages
9. Switch off the supply by opening the DPST switch.

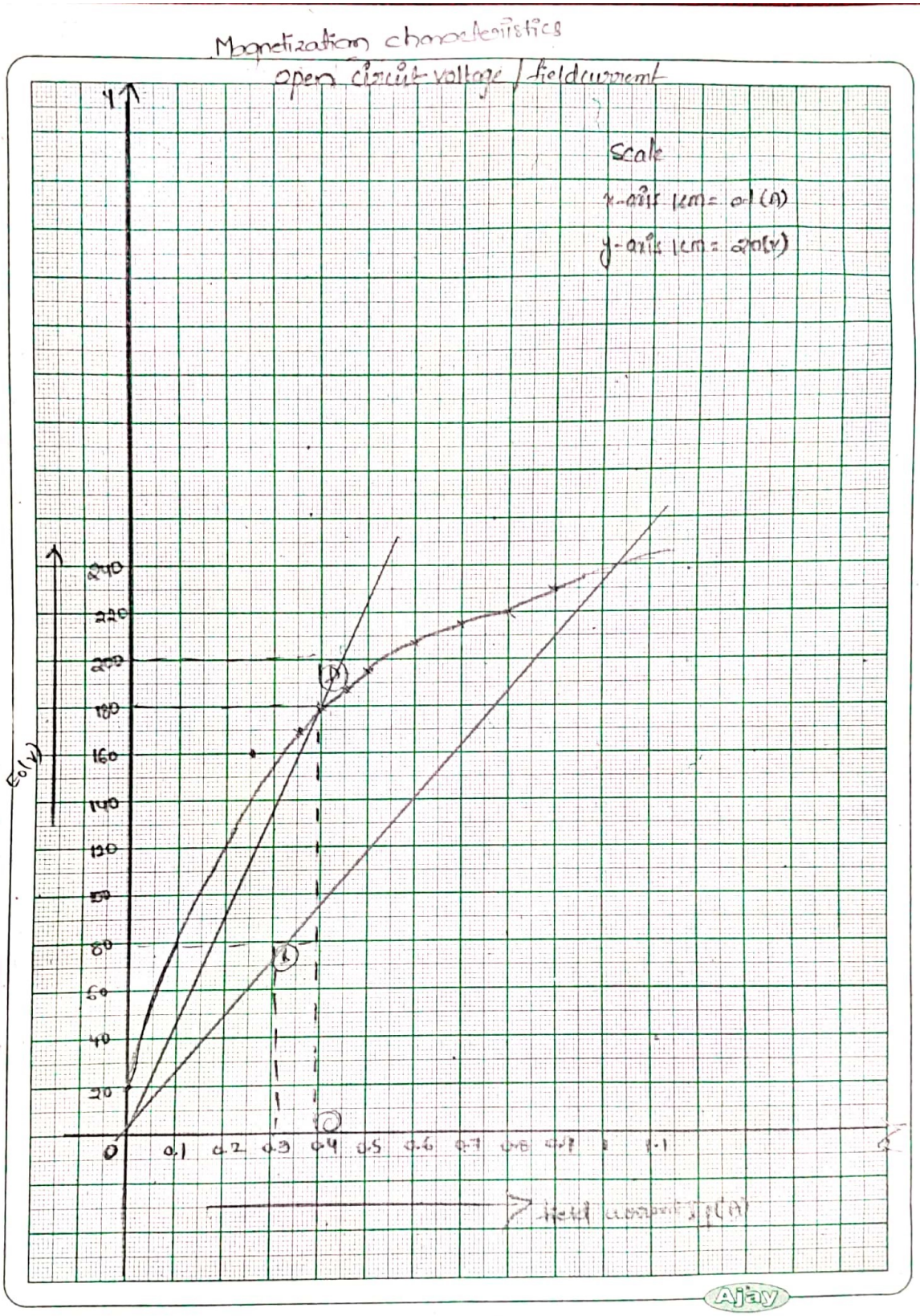
Tabular column:-

I_f (amp)	E_0 (volts)
0	20
0.35	170
0.4	180
0.45	182
0.5	192
0.6	202
0.7	212
0.8	220
0.9	231

Calculations:-

Model graph:-




Magnetization characteristics
open circuit voltage / field current
Scale
x-axis 1cm = 0.1 (A)
y-axis 1cm = 20(V)
Eo(V)
240
220
200
180
160
140
120
100
80
60
40
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
Ajay

From the graphs,

The critical field resistance = slope of the line

$$Rc = \Delta Eo / \Delta If \quad \text{ohms}$$

$$N_C = (AB/AC)*N$$

Where N_C = critical speed

N = Speed at given O.C.C

Result: -

The magnetization characteristic (O.C.C) of the given DC shunt generator are determined and hence field resistance and critical field resistance are calculated.

Viva voce

1. What is the principle involved in the operation of generator?
2. Define critical field resistance?
3. Define critical speed?
4. What are the types of generators?
5. What are the causes of failures of excitation?

2(a). LOAD TEST ON DC SHUNT GENERATOR

Aim:-

To conduct load test on dc shunt generator and obtain external characteristics and internal characteristics

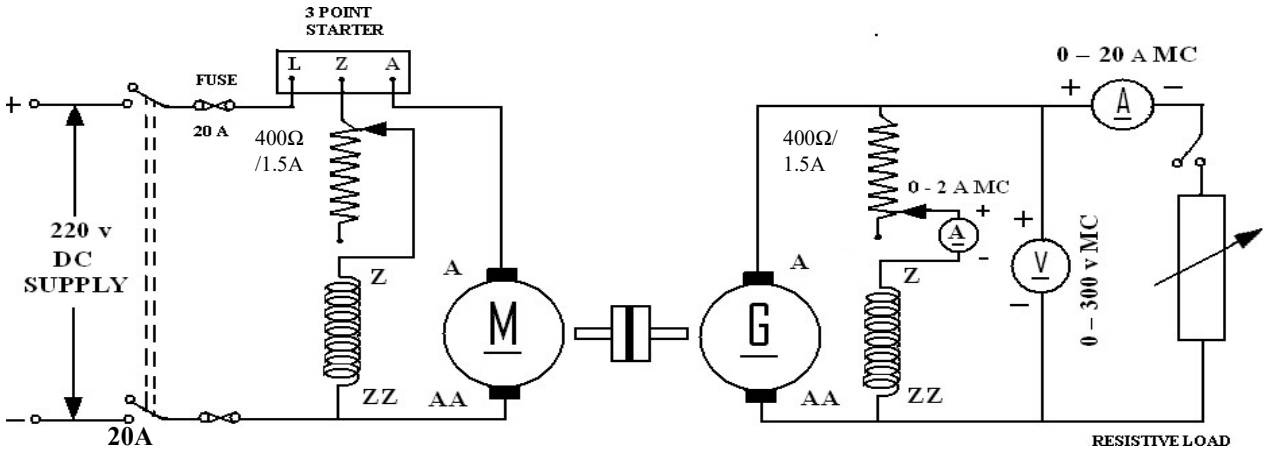
Apparatus Required:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Ammeter	(0-20)A	MC	2NO
2	Ammeter	(0-2)A	MC	1NO
3	Voltmeter	(0-300)V	MC	2NO
4	Tachometer	(0-10,000) RPM	Digital	1NO
5	Rheostat	400Ω, 1.7A	Wire wound	2NO
6	Connecting wires	(0-20)A	-	Required
7	Load box	230V,5KW/20A	Resistive	1NO

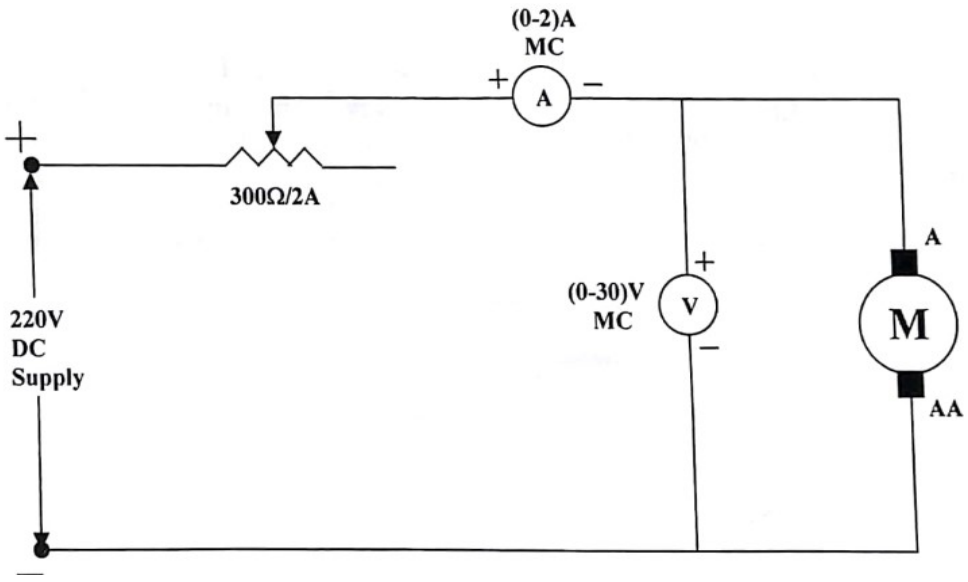
Nameplate details:-

Motor	Generator
Voltage - 220V	Voltage - 220V
Current -19A	Current -13.6A
Speed - 1500 rpm	Speed - 1500 rpm
Excitation types –shunt	Excitation type – shunt

Circuit diagram:-



To measure armature resistance:-



Theory:-

----To be written---

Procedure:-

1. Make the connections as per the circuit diagram.
2. Initially keep the motor field rheostat at minimum resistance position and generator field rheostat at maximum resistance position.
3. Give the dc supply to the circuit and start the motor with the help starter.
4. Bring the motor to rated speed by varying the field rheostat in the motor circuit.
5. Adjust the generator voltage to the rated value by using generator field rheostat.
6. Apply resistive load in steps and note down the values of terminal voltage, load current and field current.
7. Increase the load till rated current is obtained.

To determine Armature resistance:-

1. Connect the circuit as per the circuit diagram.
2. Switch on dc supply.
3 .Increase the load and note down the voltage and current.

Tabular columns:-

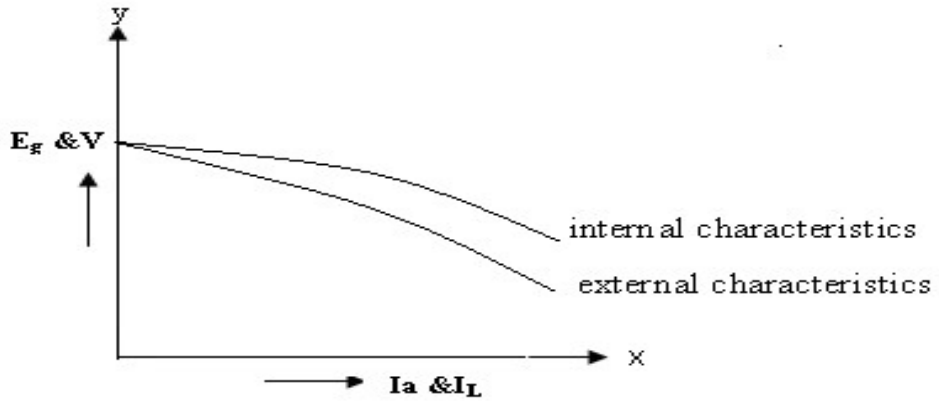
Table1:

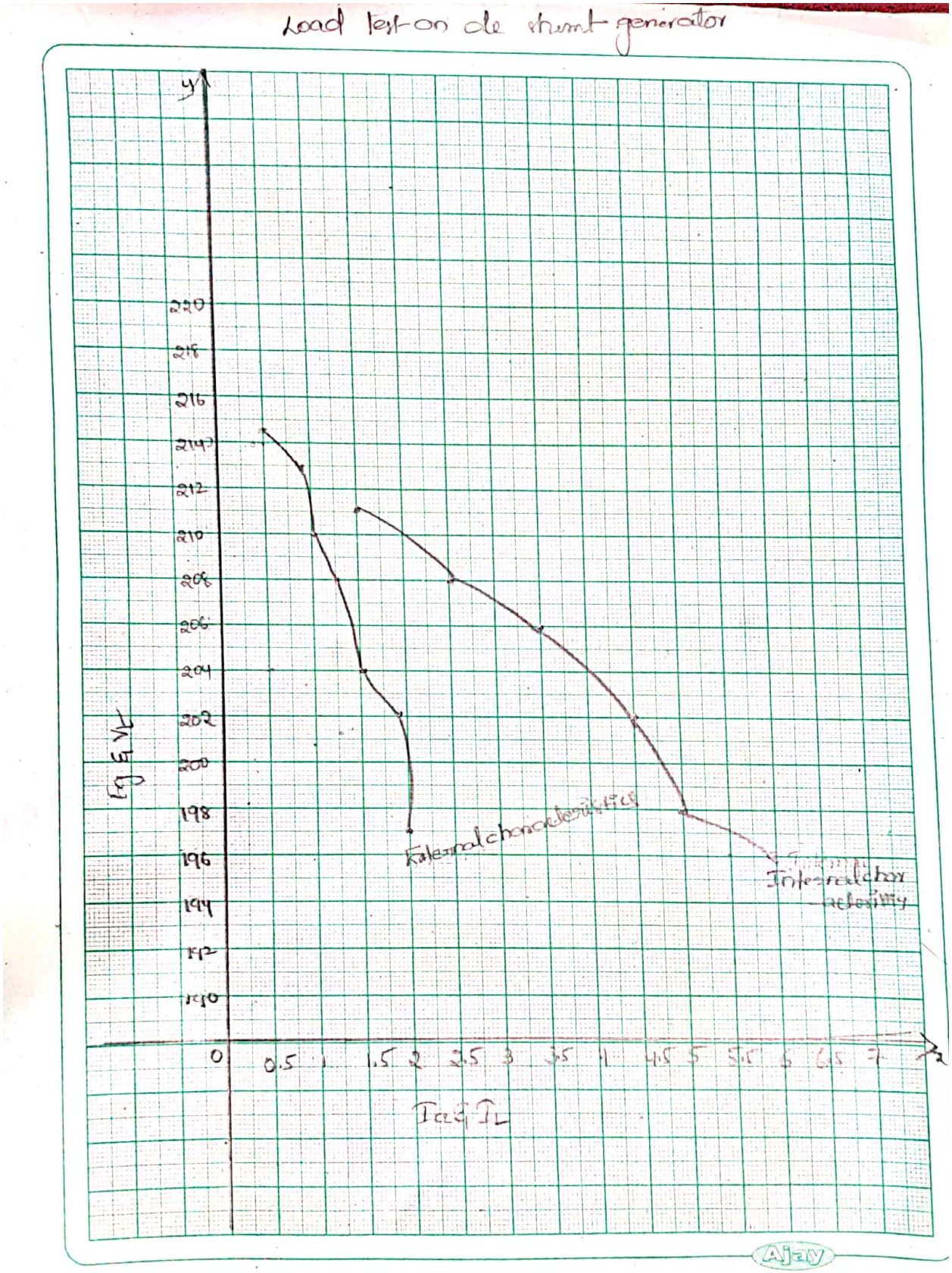
Terminal Voltage (Volts)	Load Current (I_L)	Field Current (I_f)	$Ia = I_L + I_f$ (amp)	$E_g = V + IaR_a$ (volts)
214.7	0.4	0.5	0.9	215.65
211.8	1.5	0.9	2.4	213.5
208.6	2.5	1	3.5	210.5
206.1	3.5	1.2	4.7	208.38
202	4.5	1.5	6	204.85
198.5	5	1.5	6.5	201.35
194.1	6.5	2	8.5	197.9
191.1	7.5	2	9.5	194.9

Table2: Armature Resistance

V(volts)	I(amp)	R_a= (V/I) (ohms)

Model graph:-




Load test on dc shunt generator
Y
220
218
216
214
212
210
208
206
204
202
200
198
196
194
192
190
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
X
Eg & VL
Ia & IL
External characteristics
Internal char
acteristics

Result: -

Internal and external characteristics of dc shunt generator are drawn by conducting load test on it.

Viva voce

1. What is the condition for maximum efficiency?
2. What is the difference between cumulative and differential compound motor?
3. What is torque?
4. What is back Emf?
5. What are the applications of dc shunt motors?

2(b).LOAD TEST ON DC COMPOUND GENERATOR

Aim:-

To conduct load test on a given dc compound generator when acts as

1. Cumulative compound generator
2. Differential compound generator **and** to draw the characteristics.

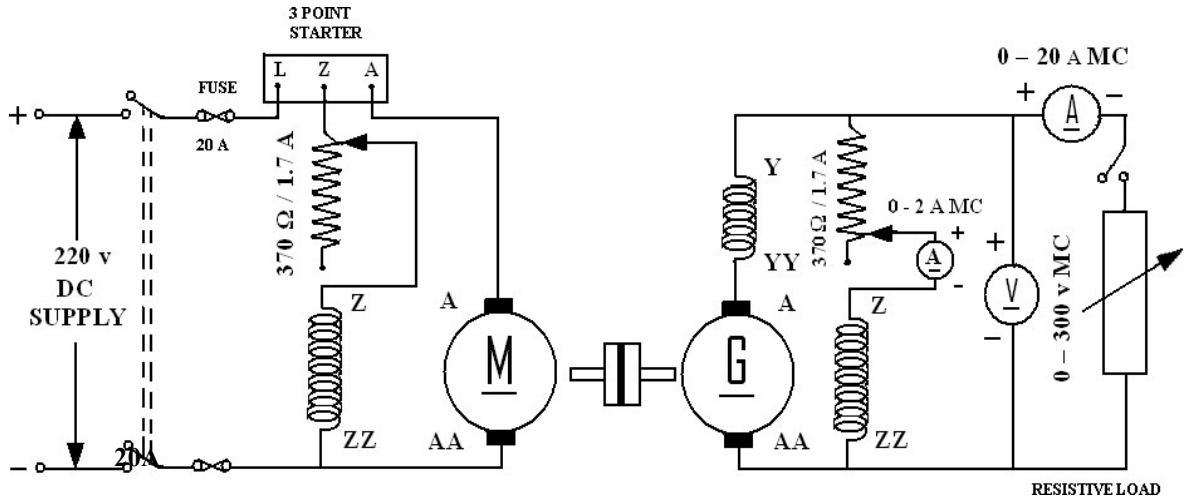
Apparatus Required:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Ammeter	(0-20)A	MC	2NO
2	Ammeter	(0-2)A	MC	1NO
3	Voltmeter	(0-300)V	MC	2NO
4	Tachometer	(0-10,000) RPM	Digital	1NO
5	Rheostat	400Ω, 1.7A	Wire wound	2NO
6	Connecting wires	(0-20)A	-	Required
7	Load box	230V,5KW/20A	Resistive	1NO

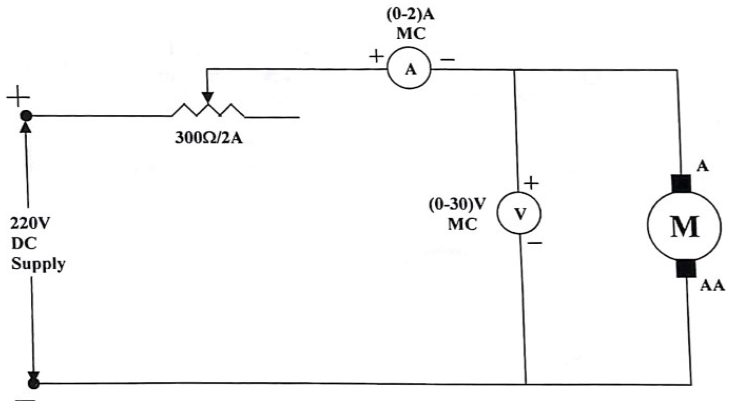
Nameplate details:-

Motor	**Generator**
Voltage - 220V	Voltage - 220V
Current -19A	Current -13.6A
Speed - 1500 rpm	Speed - 1500 rpm
Excitation type –compound	Excitation type – compound

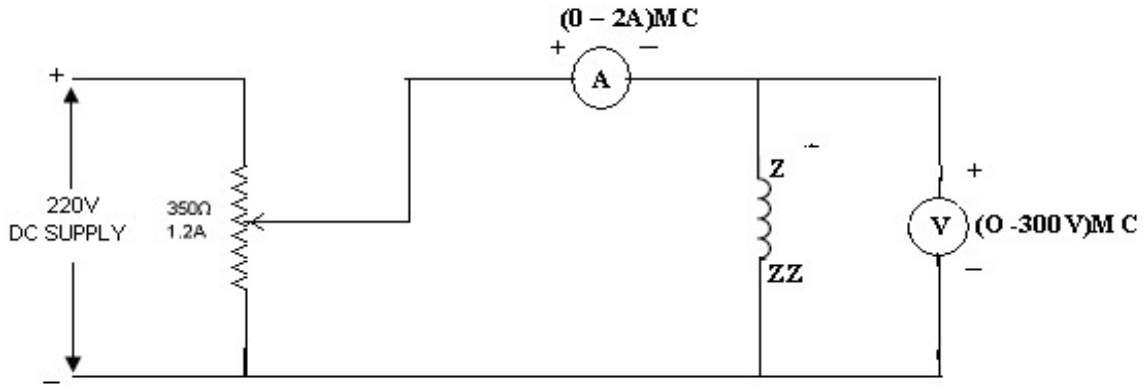
Circuit diagram:-



ii) To find armature resistance:-



iii) To find series field resistance:-



Theory:-

----To be written---

Procedure:-

1. Make the connections as per the circuit diagram.
2. Keep the motor field rheostat in minimum position and generator field rheostat in maximum position.
3. Keep the field winding in cumulative mode i.e. current flows from z to zz in Shunt field winding, from y to yy in series field winding.
4. Give the dc supply to the circuit and start the motor with the help starter.
5. Bring the motor to rated speed by varying the field rheostat in the motor circuit.
6. Adjust the generator voltage to the rated value by using field rheostat of generator.
7. Increase the load in steps and note down the values of terminal voltage, load current and field current.
8. Increase the load till rated current is obtained.
9. Interchange the field winding y and yy for differential mode and conduct experiment in above procedure

To determine armature and field resistance:-

1. Connect the circuit as per the circuit diagram.
2. Switch on dc supply.
3. Increase the load and note down the voltage and current.

Tabular columns:-

Table1 :Cumulative Mode:-

Terminal Voltage(V)	Load Current(I_L)	Field Current(I_f)	Ia = $I_L + I_f$ (Amp)	E_g=V+Ia(R_a+R_{se}) (Volts)
220	0	0.75	0.75	222.7
220	1.6	0.76	2.36	228.09
220	4	0.75	4.76	237.13
220	6	0.74	6.74	244.26
220	7.5	0.74	8.24	249.2
220	10	0.74	10.74	258.6
220	11	0.7	11.7	262.2

Table2:Differential Mode:-

Terminal Voltage(V)	Load Current(I_L)	Field Current(I_f)	Ia = $I_L + I_f$ (amp)	E_g=V+Ia(R_a+R_{se}) (volts)
220	0	0.8	0.8	222.8
210	1.5	0.75	2.25	218.1
170	3.4	0.7	4.1	204.7
173	4.5	0.65	5.15	193.3
150	5	0.56	5.36	100.01

Table2: Armature Resistance

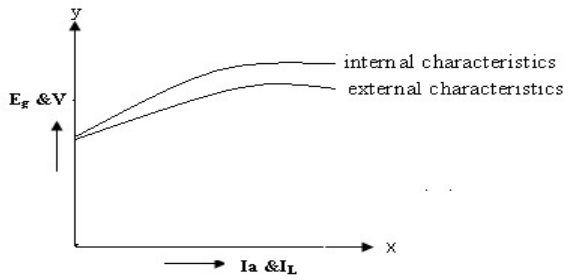
V(volts)	I(amp)	R_a =(V/I) (ohms)

Table3: Series field winding Resistance

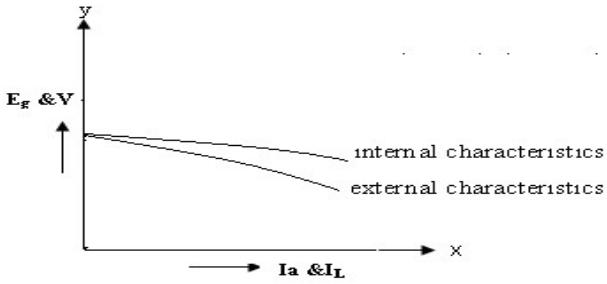
V(volts)	I(amp)	R_{se} =(V/I) (ohms)

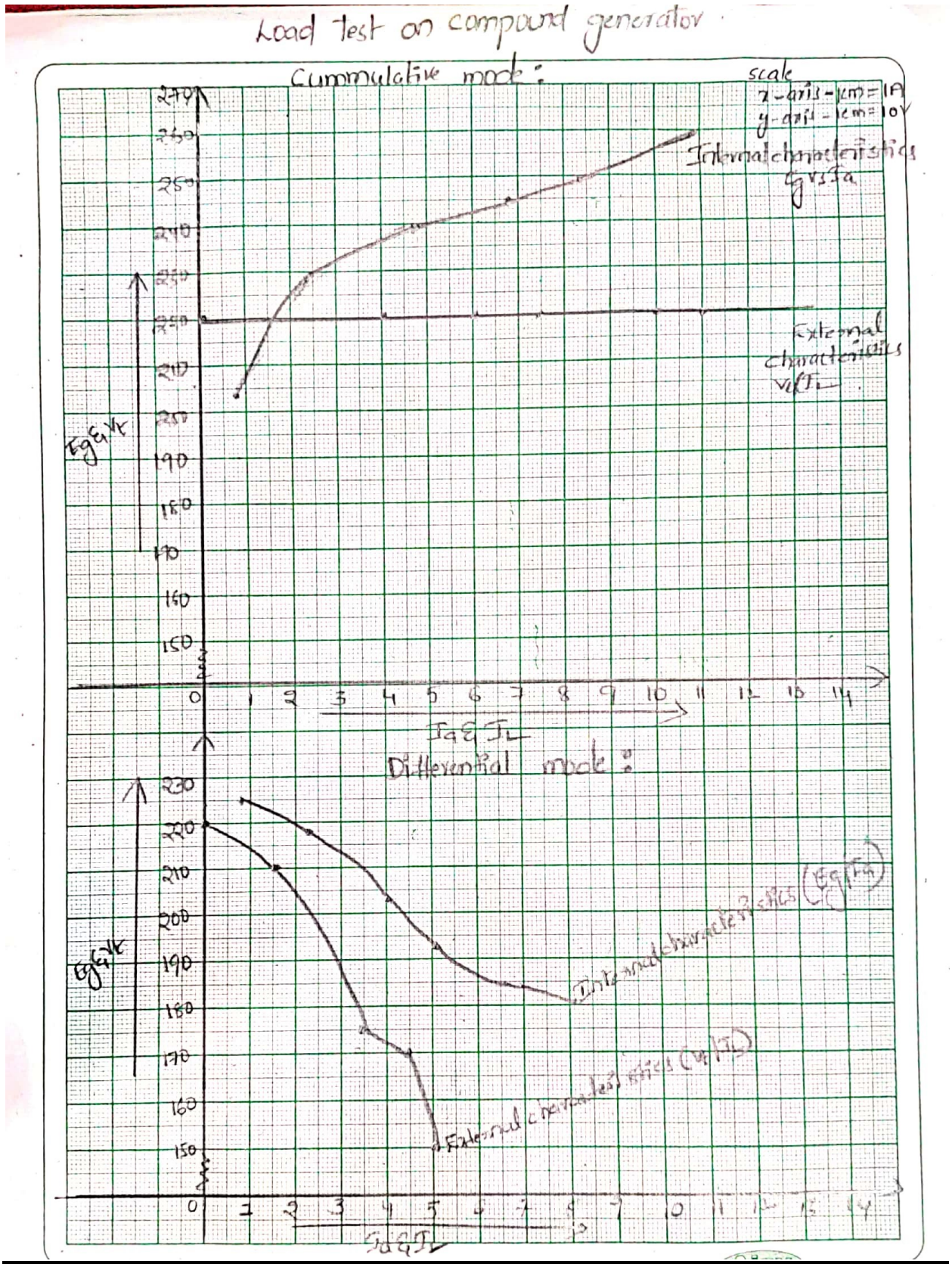
Model graph:-

Cumulative Mode:-



Differential Mode:-




Load test on compound generator
Cummulative mode:
scale
x-axis - 1cm = 1A
y-axis - 1cm = 10V
Internal characteristics Eg vs Ia
External characteristics V vs IL
Eg, V
IaorIL
Differential mode:
Eg, V
Internal characteristics (Eg vs Ia)
External characteristics (V vs IL)
IaorIL

Result:-

Internal and external characteristics of dc compound generator (both cumulative and differential) are drawn by conducting load test on it.

Viva voce

1. What is Armature reaction?
2. What is the basic principle of generator?
3. What are the types of compound generators?
4. What are the applications of compound generators?
5. What are the types of compound generators?

3. SWINBURN'S TEST ON A GIVEN DC SHUNT MACHINE

Aim:-

To conduct Swinburne's test on a given dc shunt machine and to determine

1. It's efficiency when acting as a generator.
2. It's efficiency when acting as a motor.

Apparatus Required:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-300)V	MC	1NO
2	Ammeter	(0-2)A	MC	1NO
3	Ammeter	(0-20)A	MC	1NO
4	Rheostat	400 Ω, 1.2A	Wire wound	1NO
5	Tachometer	(0-10,000)rpm	Digital	1NO
6	Connecting wires	(0-20)A	-	Required

Name plate details:-

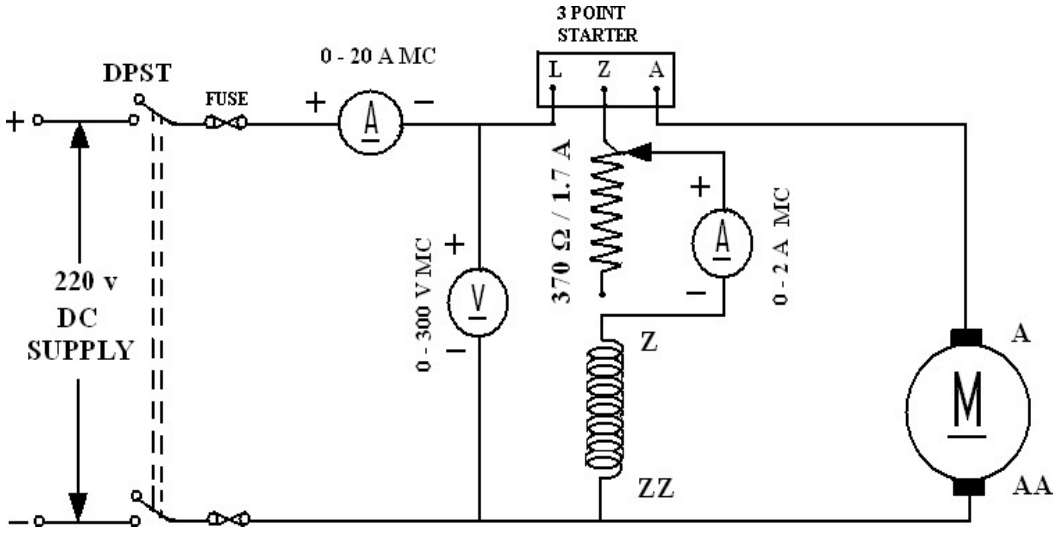
Volts : 220 V

Current : 19A

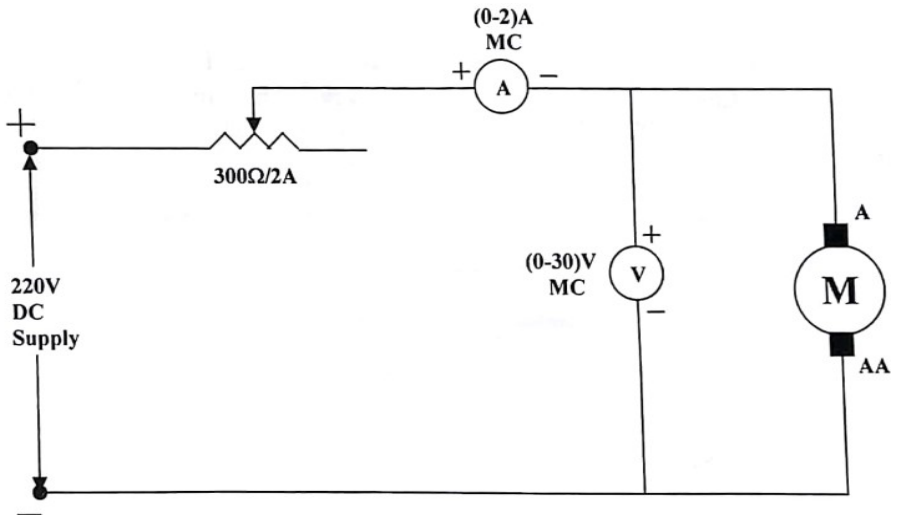
RPM : 1500

H.P : 5.0

Circuit diagram:- **a) No-Load Test:-**



b) To find Ra:-



Theory:-

----To be written---

Procedure:-

1. Make the connections as per the circuit diagram.
2. Initially keep the motor field rheostat in minimum resistance position and SPST switch in closed position.
3. Give the supply by closing DPST switch and start the motor with the help of 3-point starter.
4. Get the rated speed by varying shunt field rheostat.
5. Open the SPST switch across the ammeter and note down the voltmeter and ammeter readings.
6. Switch off the by opening the DPST switch.

To determine armature resistance:-

1. Make the connections as per the circuit diagram.
2. Switch on dc supply.
3. By increasing the load in steps and note down the voltage and current.
4. Switch off the by opening the DPST switch.

Tabular columns:-

Table 1: No-Load Test

V (volts)	Ia_0 (Amp)	I_{f0}(Amp)
220	1.5	0.65

Table2: Armature Resistance

V(volts)	I(Amp)	R_a =(V/I) (ohms)

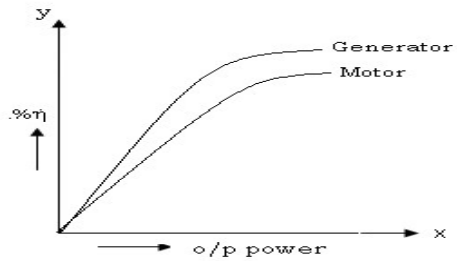
Table3: Efficiency of dc machine when running as a Motor

I_L	I/P power	Ia (amp)	$Ia^2 R_a$ (watts)	Total losses = $w_c + Ia^2R_a$	O/P= I/P – Total losses	$\%\eta$ = ((O/P)/(I/P))*100
4.75	1045	4.15	32.72	393.62	651.8	62.3
9.5	2090	8.9	150.5	511.41	1518.6	75.5
14.25	3135	13.65	354.01	714.9	2420.6	77.2
19	4180	18.4	643.26	1004.16	3175.8	75.9

Table 4: Efficiency of dc machine when running as a Generator

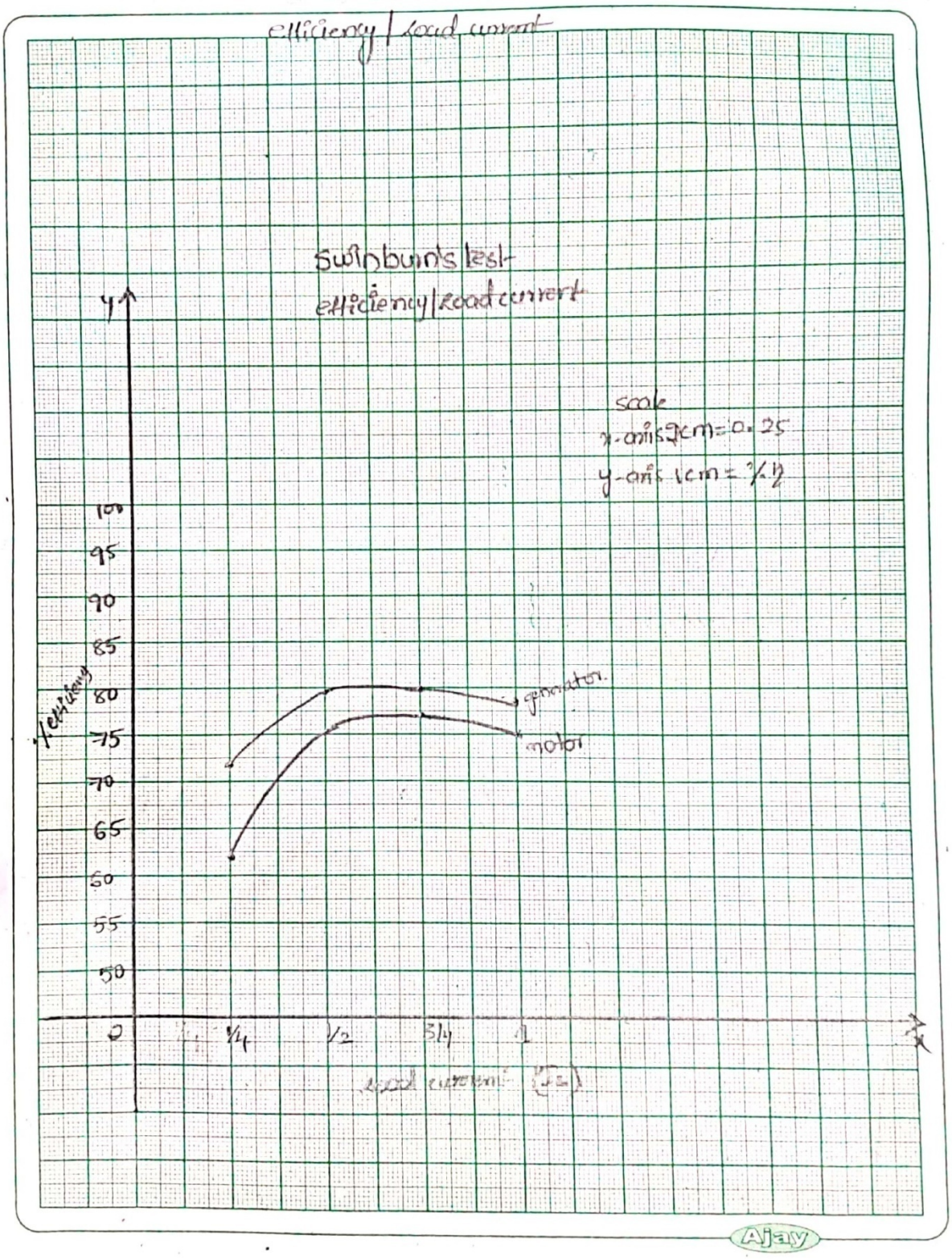
I_L	o/p power	Ia	$Ia^2 R_a$	Total losses = $w_c + Ia^2R_a$	i/p= o/p + total losses	$\%\eta$ = ((o/p)/(i/p))*100
4.75	1045	5.35	54.38	415.28	7460.2	71.5
9.5	2090	10.1	193.8	554.72	2644.7	79.02
14.25	3135	14.85	418.9	779.9	3914.9	80.07
19	4180	19	720.9	1098.8	5270.8	79.3

Model graph:- Draw the graph between output power on x-axis and efficiency on y-axis as shown below.



swinburn's test

efficiency / load current



CALCULATIONS

Constant losses = $w_c = V*I_0 - Ia_0^2 * R_a$

Constant losses = $w_c = V*(Ia_0 + I_{f0}) - Ia_0^2 * R_a$

Efficiency when running as a Motor:

$Ia = I_L - I_{f0}$

Input $= V*I_L$

Armature cu loss = $Ia^{2*} R_a$

Constant losses = w_c

Total losses = $Ia^{2*} R_a + w_c$

Output = input - losses

%ή = ((o/p)/(i/p))*100

Efficiency when running as a Generator:

$Ia = I_L + I_{f0}$

Output $= V*I_L$

Armature cu loss = $Ia^{2*} R_a$

Constant losses =. w_c

Total losses = $Ia^{2*} R_a + w_c$

Input = Output + losses

%ή = ((o/p)/(i/p))*100

Result:- The efficiency of a given dc machine is calculated when it is operating as generator as well as motor action by conducting the no-load test.

Viva voce

1. What are the different types D.C.motors?
2. What is the necessity of starter?
3. What is the basic principle of motor?
4. Why the series motor has not used for swinburne's test?
5. What are the applications of series generators?

4. HOPKINSONS TEST ON DC SHUNT MACHINES

Aim:-

To conduct the Hopkinton's test on a given dc-motor and to determine the efficiency.

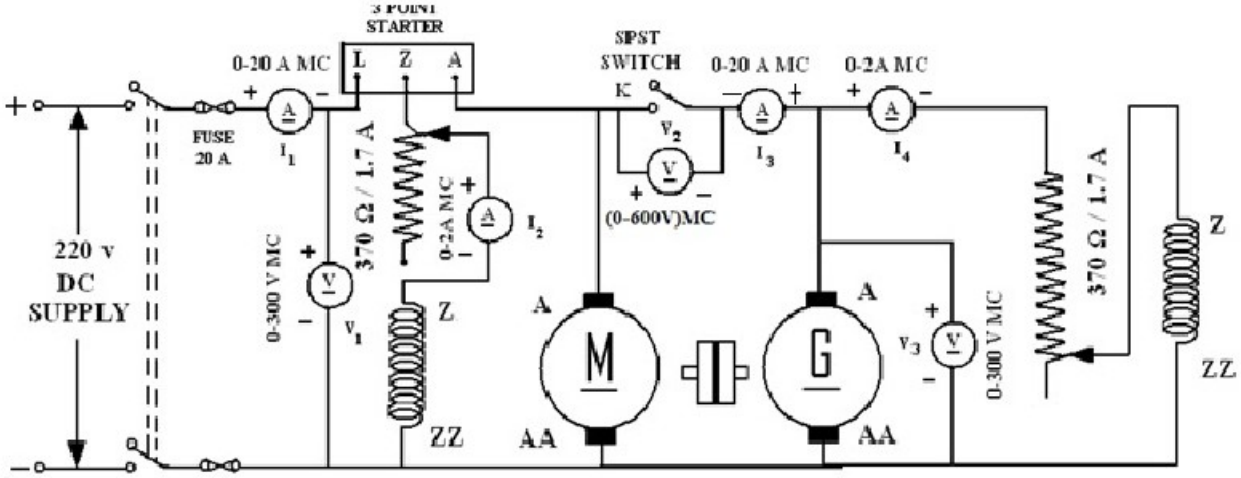
Apparatus:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-300)V	MC	1NO
2	Voltmeter	(0-500)V	MC	1NO
	Ammeter	(0-25)A	MC	1NO
3	Ammeter	(0-2)A	MC	1NO
4	Tachometer	(0-10,000) RPM	Digital	1NO
5	Rheostat	250 Ω/ 1.7A	Wire wound	2NO
6	Connecting wires	(0-20)A	-	Required
7	SPST switch	(0-20)A	Open	1NO

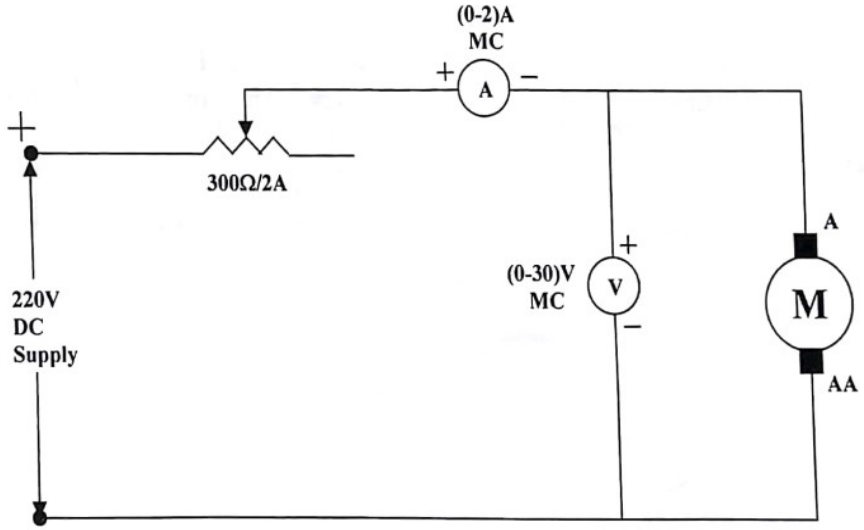
Nameplate details:-

Motor	**Generator**
Voltage - 220V	Voltage - 220V
Current -19A	Current -13.6A
Speed - 1500 rpm	Speed - 1500 rpm
Excitation type –shunt	Excitation type - shunt

Circuit diagrams:-



To measure armature resistance:-



Theory:

----To be written---

Procedure:-

1. Connect the circuit as per the circuit diagram.
2. Ensure that the motor field rheostat should be in minimum position and generator field rheostat should be in minimum output voltage position and also The SPST switch should be in open position at starting.
3. Give dc supply to the dc machine by closing the DPST switch and start the motor with the help of 3-point starter.
4. Adjust the motor field rheostat till the rated speed is obtained.
5. Adjust the generator field rheostat till the voltmeter across the SPST switch shows zero reading and then close the SPST switch .
6. By varying the generator field rheostat note down the readings of terminal voltage, generator field current, motor field current, output current of generator and total input current from the supply.
7. Repeat step 6,till the rated current of generator is obtained.
8. Switch off the dc supply by opening the DPST switch.

To determine armature resistance:-

1. Connect the circuit as per the circuit diagram.
2. Switch on dc supply.
3. Increase the load and note down the voltage and current.

Armature Resistance

V	**I**	**R_a =(V/I)**

Tabular column1:

S. No	Input Voltage V (volts)	Total input current I_1 (amps)	Generator field current I_4 (amps)	Motor Field current I_2 (amps)	Generator Output current I_3 (amps)	Input power $W_i = V*I_1$ (watts)	Armature cu losses of motor $W_{cu,m} = (I_1 + I_3 - I_2)^2 * R_a$ (watts)	Armature cu losses of generator $W_{cu,g} = (I_4 + I_3)^2 * R_a$)	Motor field cu losses $W_{sh\,m} = V* I_2$ (watts)
1	230	3	0.5	0.8	1	690	19.45	4.29	184
2	230	3	0.55	0.8	1.5	690	26	7.98	184
3	230	3	0.57	0.8	2.5	690	41.97	17.9	184
4	230	3	0.58	0.8	3	690	51.37	24.35	184
5	230	3	0.6	0.8	3.5	690	61.73	31.94	184

Tabular column1:

Generator field cu losses $W_{sh,g} = V* I_4$ (watts)	Stray losses $Ws = W_i - \{W_{cu,m} + W_{cu,g} + W_{sh,g} + W_{sh,m}\}$ (Watts)	Total losses of motor $W_m = W_{cu,m} + W_{sh,m} + Ws/2$ (Watts)	Total losses of generator $W_g = W_{cu,g} + W_{sh,g} + Ws/2$ (Watts)	% efficiency of Generator $\%\eta_g = [(VI_3)/((V I_3) + W_g)]*100$	% efficiency of motor $\%\eta_m = \frac{V(I_1 + I_3 - I_2) - W_m *100}{V(I_1 + I_2 - I_4)}$
115	367.2	387.1	302.9	43.16	57.9
126.5	345.5	382.7	307.2	52.9	63.02
131.1	315.03	383.4	306.5	65.23	69.9
133.4	296.87	383.8	306.6	69.26	72.2
138	276.38	383.9	304.07	73.74	74.32

Calculations:-

Input voltage V=___ volts

Total input current from the supply I_2 =____amps

Generator field current I_4 =____amps

Motor field current I_3 =____amps

Generator output current I_1 =____amps

Input power to the set $W_i = V^* I_2$ watts

Armature copper losses of motor $W_{cu,m} = (I_1 + I_2 - I_4)^2 * R_a$ watts

$W_{cu,m}$ = _____ watts

Armature copper losses of generator $W_{cu,g} = (I_1 + I_3)^2 * R_a$ watts

$W_{cu,g}$ =_____watts

Generator field copper losses $W_{sh,g} = V^* I_3$ watts

$W_{sh\,g}$ = _____ watts

Motor field copper losses $W_{sh,m} = V^* I_4$ watts

$W_{sh,m}$ = _____ watts

Stray losses $Ws = W_i - \{ W_{cu,m} + W_{cu,g} + W_{sh,g} + W_{sh,m} \}$ Watts

Ws =_____Watts

Total losses of motor $W_m = W_{cu,m} + W_{sh,m} + Ws/2$ Watts

Total losses of motor W_m = _____Watts

Total losses of generator $W_g = W_{cu,g} + W_{sh,g} + Ws/2$ Watts

Total losses of generator W_g = _____ Watts

Percentage efficiency of motor $\%\eta_m = \dfrac{V(I_1 + I_2 - I_4) - W_m}{V(I_1 + I_2 - I_4)} * 100$

Percentage efficiency of generator $\%\eta_g = \dfrac{(V I_1)}{((V I_1) + W_g)} * 100$

Result:

Hopkinson's test is conducted on a given DC shunt machines and efficiency is calculated for both motor and generator

Viva voce

1. What is the main advantage of the Hopikinson's test?
2. What is the main disadvantage of the Hopikinson's test?
3. What is the need of the voltmeter which connected between motor and generator?

5. BRAKE TEST ON DC SHUNT MOTOR

Aim:-

To conduct Brake test on dc shunt motor and to draw the performance curves of the motor.

Apparatus Required:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-300)V	MC	1NO
2	Ammeter	(0-20)A	MC	1NO
3	Ammeter	(0-2)A	MC	1NO
4	Rheostat	400Ω, 1.7A	Wire wound	1NO
5	Tachometer	(0-10,000) RPM	Digital	1NO
6	Connecting wires	(0-20)A	-	Required

Nameplate details:-

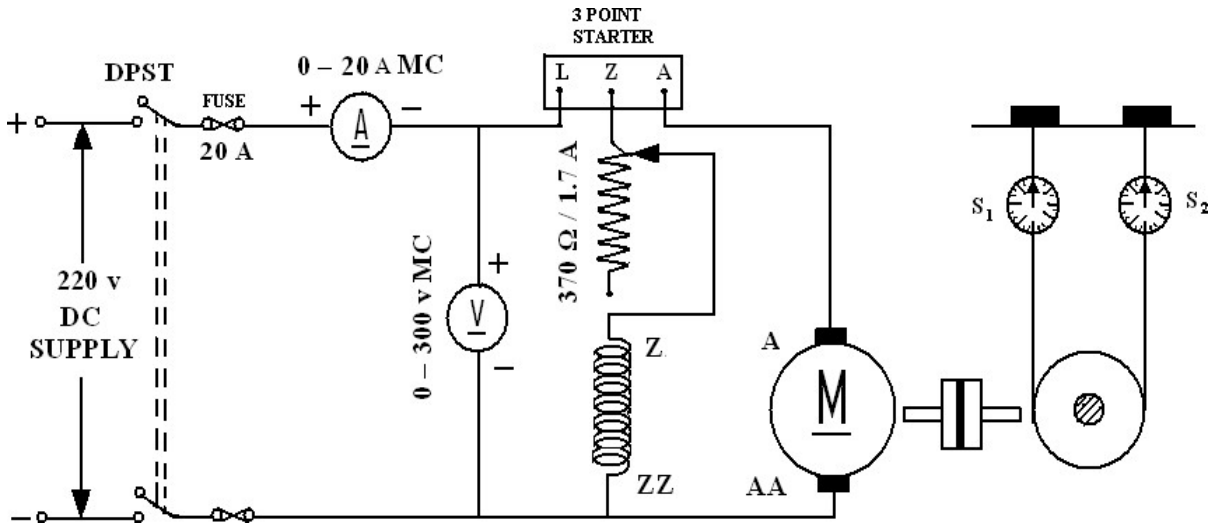
Voltage - 220V

Current -12A

Speed - 1500 rpm

Excitation type –shunt

Circuit diagram:-



Theory:-

----To be written---

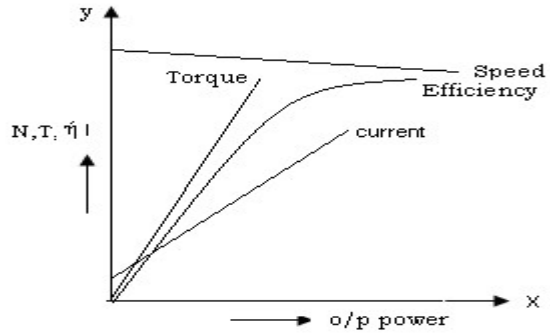
Procedure:-

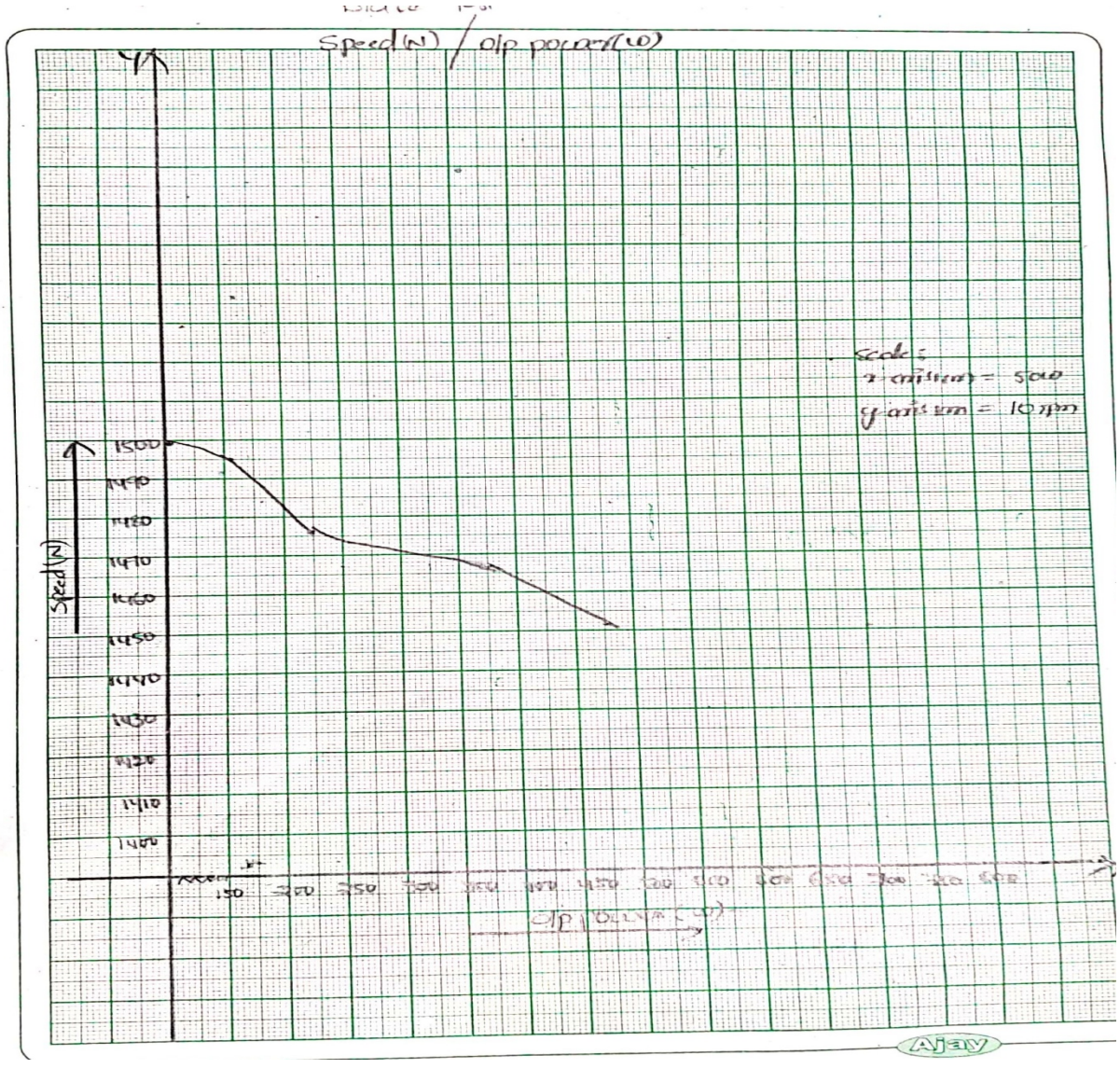
1. Make the connections as per the circuit diagram.
2. Initially keep the motor field rheostat in minimum resistance position.
3. Give the supply by closing DPST switch and start the motor with the help of 3- point starter.
4. Adjust the motor field rheostat till the rated speed is obtained.
5. Apply the load on brake drum in steps.
6. Note down the readings of speed, voltmeter, ammeter and spring balance.
7. Repeat step 5 and 6 until rated current is obtained.
8. Remove the load on the motor before switching off the supply.

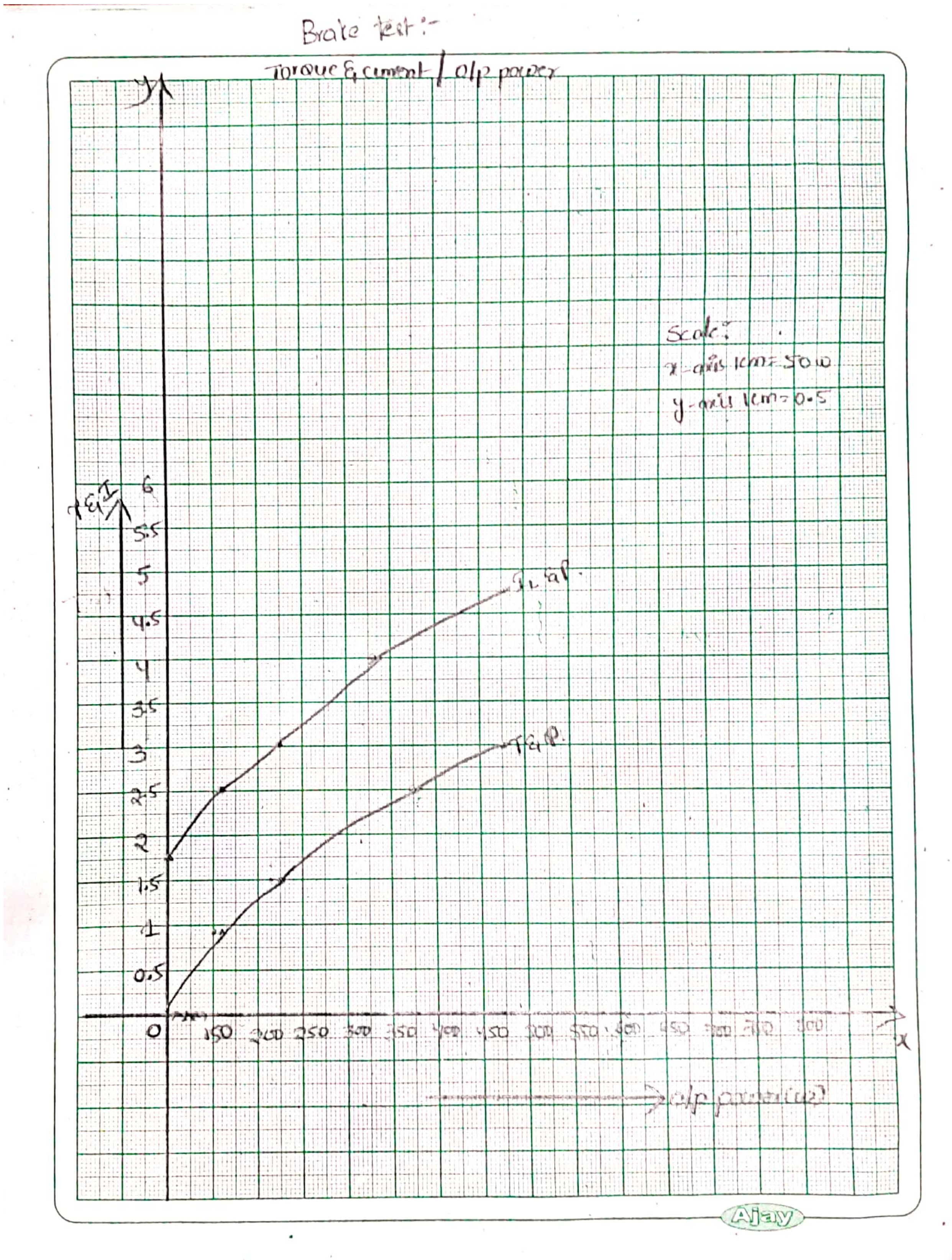
Tabular columns:-

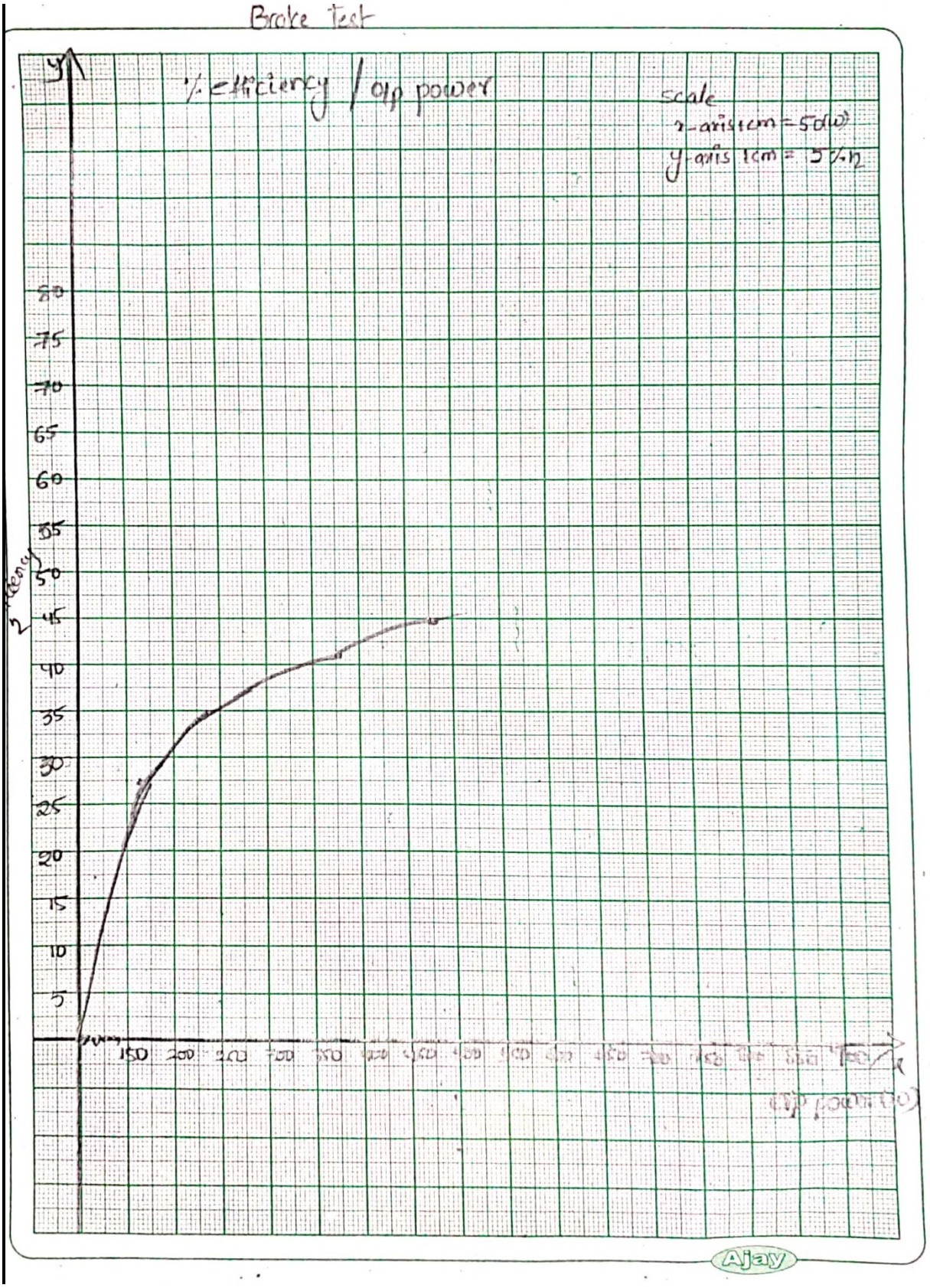
Voltage (volts)	**Current (amp)**	**Speed (rpm)**	**i/p=VI (watts)**	**S_1 Kg**	**S_2 Kg**	**Torque= (S1≈S2)* r* 9.81 (N-m)**	**o/p = 2ΠNT/60 (watts)**	**%ή= output / input*100**
220	1.7	1500	374	0	0	0	0	0
220	2.5	1496	550	0.5	0.5	0.98	153.6	27.9
220	3	1476	660	1	1	1.47	227.9	34.4
220	4	1466	880	1.5	4	2.45	376.5	42.7
220	4.5	1452	990	2	5	2.94	477.9	45.2

Model graph:- Draw the graph between output power on x-axis and speed , torque, efficiency & load current are on y-axis as shown below.






Brake test:-
Torque & current / o/p power
Scale:
x-axis 1cm = 50 W
y-axis 1cm = 0.5
I & o/p
T & o/p
o/p power (W)


Brake Test
% efficiency / o/p power
scale
x-axis 1cm = 50(W)
y-axis 1cm = 5%η
% efficiency
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
150
200
Ajay

Result:-

Brake test is conducted on dc shunt motor and hence performance curves are plotted.

Viva voce:

1. Define Torque?
2. What is the need of starter?
3. What are the types of starters?
4. Can we conduct Brake test on series motor?

6. SPEED CONTROL OF DC SHUNT MOTOR

Aim:-

To conduct the speed control of dc shunt motor by using following methods

(i) Armature control method.

(ii) Field control method.

Apparatus Required:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-300)V	MC	1NO
2	Ammeter	(0-20)A	MC	1NO
3	Ammeter	(0-2)A	MC	1NO
4	Rheostat	400Ω, 1.7A	Wire wound	1NO
5	Tachometer	(0-10,000) RPM	Digital	1NO
6	Connecting wires	(0-20)A	-	Required

Name plate details:-

Volts : 220 V

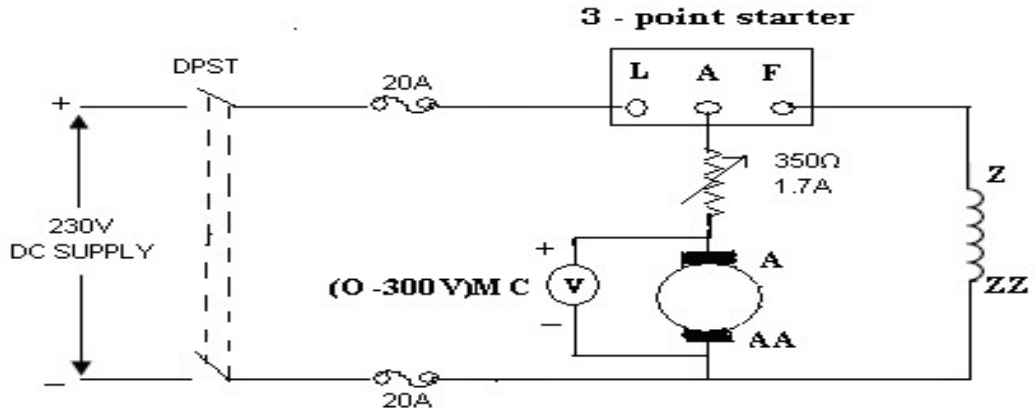
Current : 12A

RPM : 1500

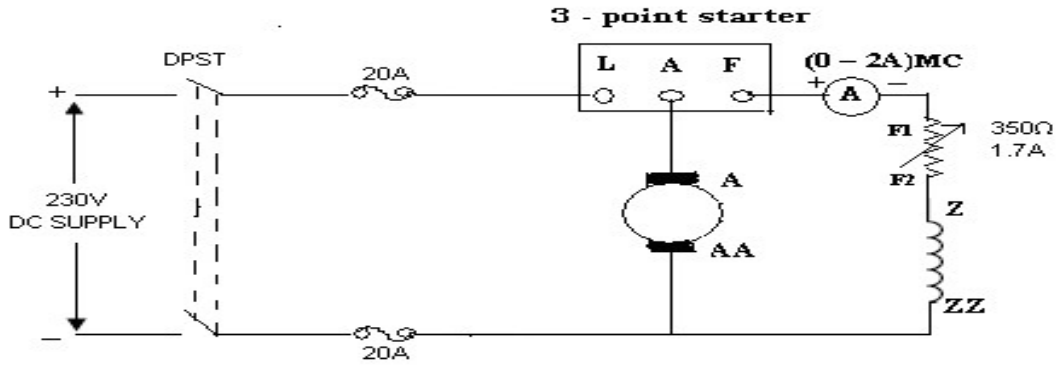
H.P : 3.0

Circuit diagram

A) Armature control method:-



B) Field control method:-



Procedure:-

Armature control method:

1. Connect the circuit as per the circuit diagram.
2. Ensure that the motor armature rheostat should be in maximum resistance position.
3. Give the dc supply to the machine by closing the DPST switch and start the motor with the help of three point starter.
4. By decreasing the resistance of rheostat, note down the readings of armature voltage and speed of the shunt motor.
5. Repeat the step no.4 till rated speed is obtained.
6. Switch off the dc supply by opening the DPST switch..

Field control method:-

1 .Connect the circuits as per the circuit diagram.

2. Ensure that the motor field rheostat should be in minimum resistance position.
3. Give the dc supply to the machine by closing the DPST switch and start the motor with the help of three point starter.
4. By increasing the resistance of field rheostat, note down the readings of field current and speed of the shunt motor.
5. Repeat the step no.4 till about 130% of rated speed is obtained.
6. Switch off the dc supply by opening the DPST switch**..**

Tabular columns:-

Armature control method:

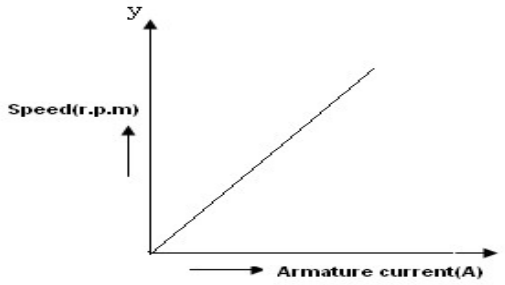
S.NO	Voltage across the armature(volts)	Speed(r.p.m)
1	100	1352
2	95	1316
3	93	1287
4	92	1273
5	90	1245

Field control method:-

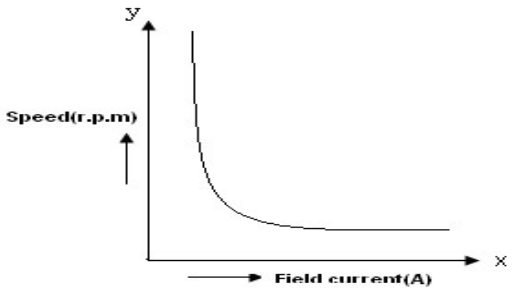
S.NO	Field current(A)	Speed(r.p.m)
1	0.58	1351
2	0.53	1376
3	0.48	1407
4	0.45	1448
5	0.39	1505

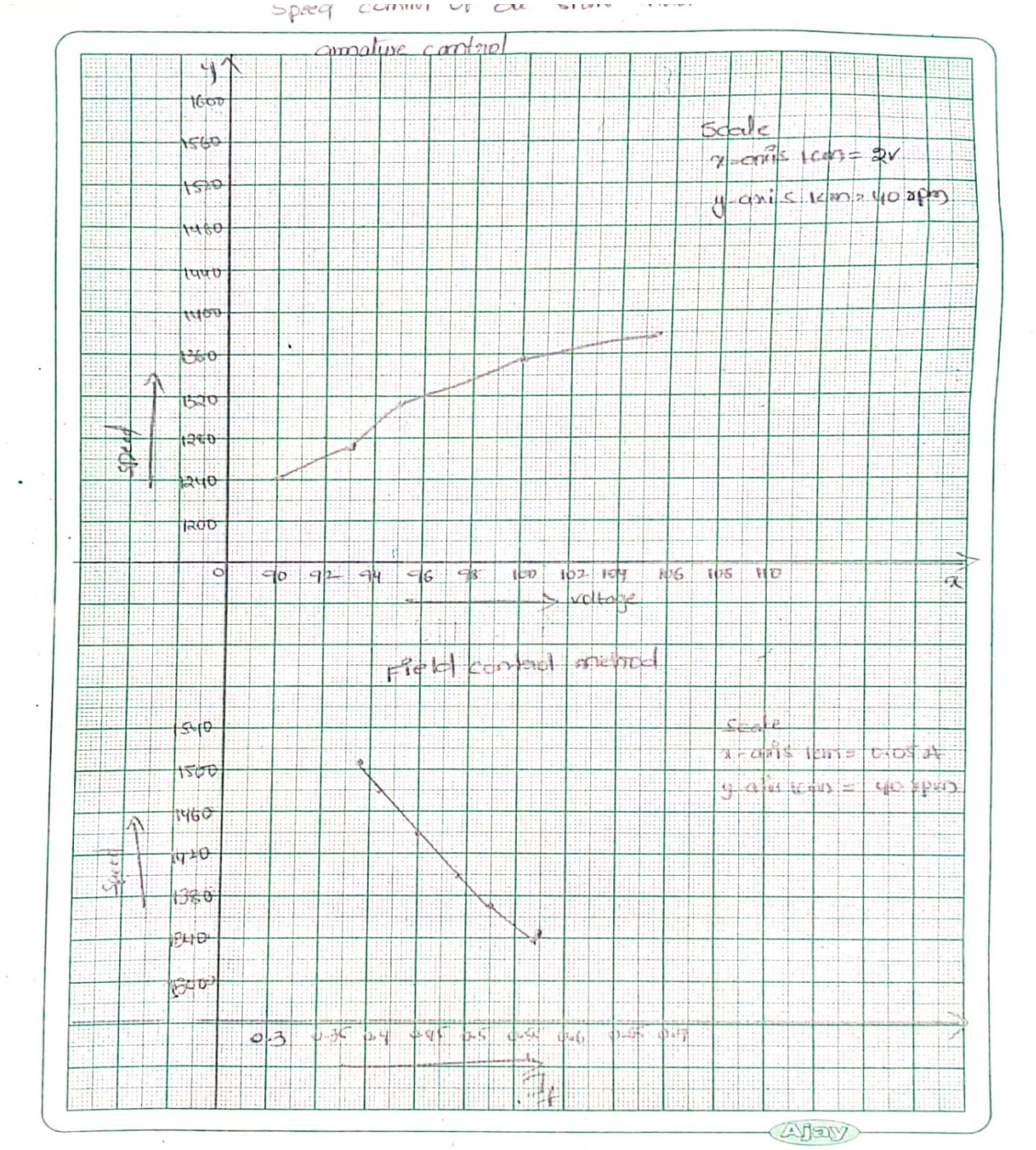
Model graphs:-

Armature control method :-



Field control method:-





Result:- Speed can be controlled by Armature voltage and flux control methods.

7. OPEN CIRCUIT & SHORT CIRCUIT TEST ON A SINGLE PHASE TRANSFORMER

AIM:

To perform open circuit and short circuit test on a single phase transformer and to pre-determine the efficiency, regulation and equivalent circuit of the transformer.

APPARATUS REQUIRED:

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeters	(0-300)V (0-150)V	MI MI	1 NO 1 NO
2	Ammeters	(0-2)A (0-20)A	MI MI	1 NO 1 NO
3	Wattmeter	(0-150)V LPF (0-2.5)A	Dynamo type	1 NO
4	Wattmeter	(0-150)V UPF (0-10)A	Dynamo type	1 NO
5	Connecting Wires	(0-20)A	*****	Required

Transformer Specifications:

Transformer Rating :(in KVA) _____

Winding Details:

LV (in Volts): _____

LV side current:_____

HV (in Volts): _____

HV side Current:_____

Type (Shell/Core):_____

Auto transformer Specifications:

Input Voltage (in Volts):_____

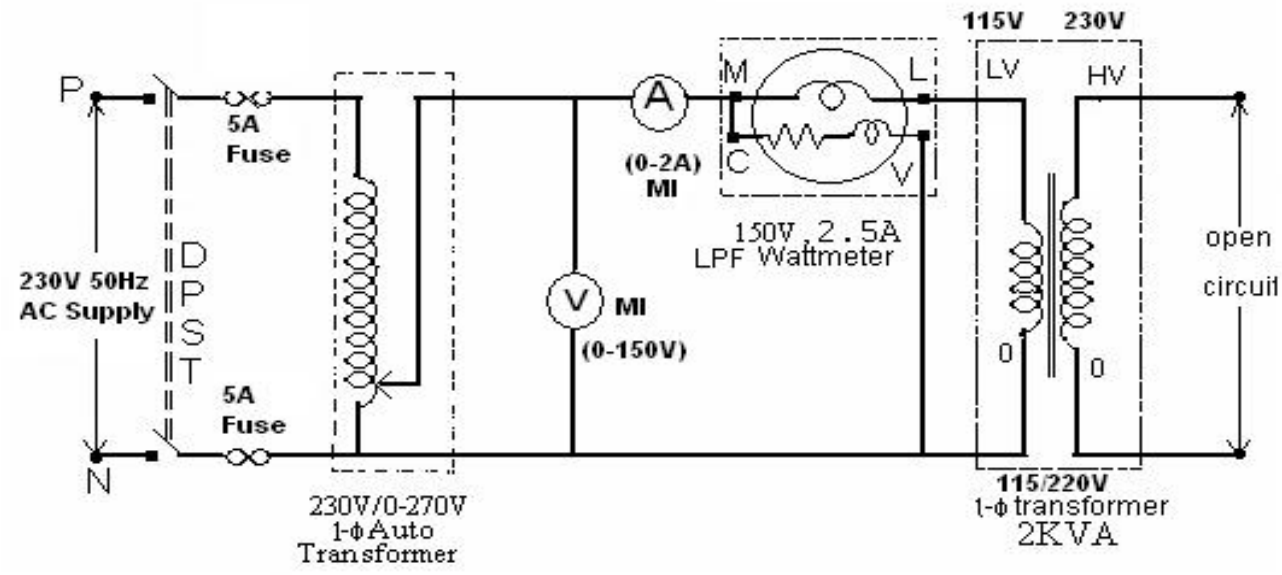
Output Voltage (in Volts): _____

frequency (in Hz):_____

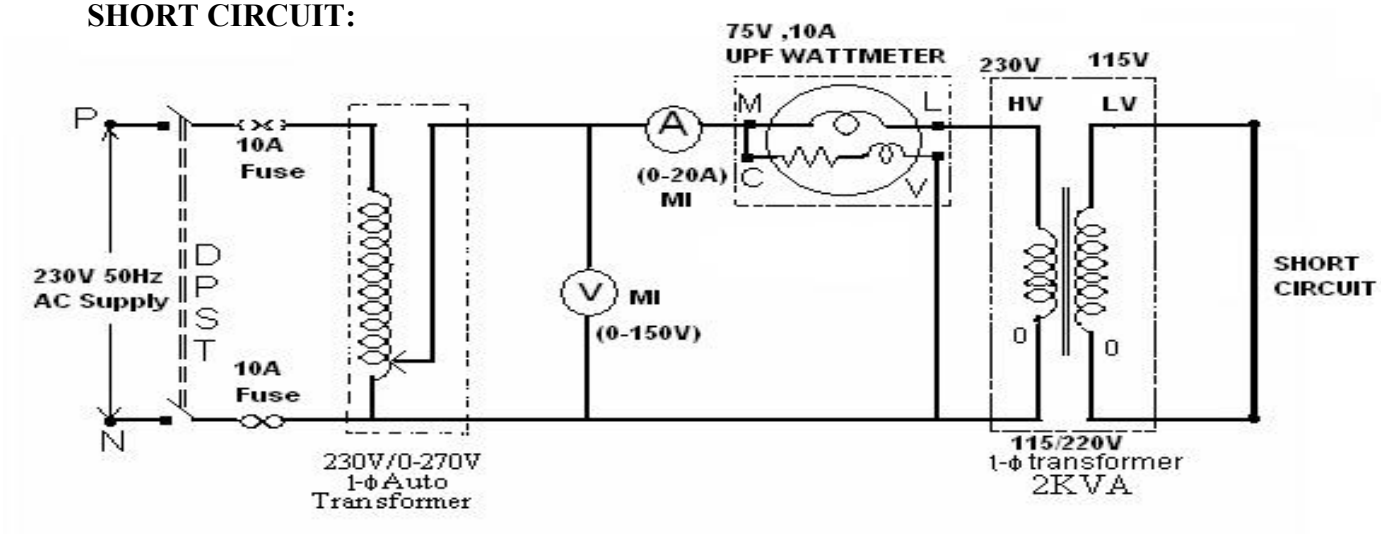
Current rating (in Amp):_____

CIRCUIT DIAGRAM:

OPEN CIRCUIT:



SHORT CIRCUIT:



PROCEDURE:

Open circuit test:

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated voltage to the Primary winding by using Variac.
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variac is set to zero output position and switch OFF the supply.
6. Calculate $\mathbf{R_o}$ and $\mathbf{X_o}$ from the readings.

Short Circuit Test:

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated Current to the Primary winding by using Variac.
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variac is set to zero output position and switch OFF the supply.
6. Calculate $\mathbf{R_{o1}}$ and $\mathbf{X_{o1}}$ from the readings.

OBSERVATIONS:

I) For OC test

S No.	Voltmeter Reading (V_o) in Volts	Ammeter Reading (I_o) in Amps	Wattmeter Reading (W_o) in Watts	R_o (Ω)	X_o(Ω)	Cos ϕ_o
1	115	0.75	44	302.63	178.29	0.51 Lag

II) For SC test

S No.	Voltmeter Reading (V_{SC}) in Volts	Ammeter Reading (I_{SC}) in Amps	Wattmeter reading (W_{SC}) in Watts	R_{01} (Ω)	X_{01} (Ω)	Z_{01} (Ω)
1	20	6.52	110	2.6	1.64	3.07

MODEL CALCULATIONS:

$R_0=V_1/I_w$,where $I_w=I_0\text{Cos}\ \phi_o$

$X_0= V_1/I_m$, where $I_m=I_0\text{Sin}\ \phi_o$

$R_{01}= W_{SC}/ I_{SC}^2$,$Z_{01}= V_{SC}/ I_{SC}$,$X_{01}=\sqrt{Z_{01}^2- R_{01}^2}$

$K=V_2/V_1$, where K=Transformation Ratio

Find the equivalent circuit parameters R_0, X_0, R_{01}, R_{02}, X_{01} and X_{02} from the O. C. and S. C. test results and draw the equivalent circuit referred to L. V. side as well as H. V. side.

Let the transformer be the step-down transformer

Primary is H. V. side.

Calculations to find efficiency and regulation:

For example at ½ full load

Cupper losses = W_{sc} x $(1/2)^2$ watts, where W_{SC} = full – load cupper losses Constant losses = W_0 watts

Output = ½ KVA x cos Φ [cos Φ may be assumed] Input = output + Cu. Loss + constant loss

Efficiency =(output /input)*100

Efficiency at different loads and P.f's

Cos Φ = _____

Regulation: From open circuit and Short circuit test

% Voltage Regulation=$(I_{2rat}/V_2)(R_{02}\text{Cos}\Theta\pm X_{02}\text{Sin}\Theta)*100$

'+' for lagging power factors

'-' for leading power factor

Power factor	Lagging pf % Regulation	Leading pf % Regulation
0	6.21	-6.21
0.2	7.42	-4.74
0.4	8.36	-3.01
0.6	8.98	-0.956
0.8	9.07	1.62

CosΦ = 1.0

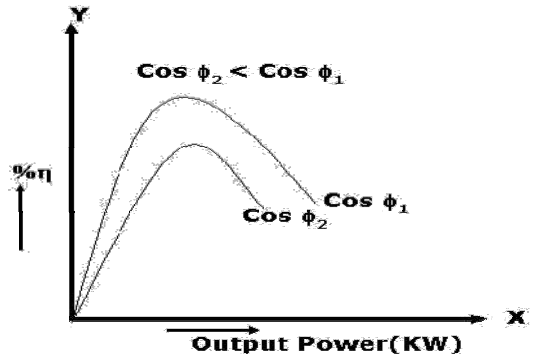
S.No	Load fraction	Load current	Wcu (W)	O/P (W)	I/P (W)	η (%)
1	1	1.3	100	1495	1637	91
2	¾	0.75	56.2	1121.5	1219.5	91.9
3	½	6.5	25	707.2	814.5	91.7
4	¼	3.25	6.25	373.7	422	88.5
5	1/8	1.625	1.5	186.8	230.4	81.09

CosΦ = 0.8

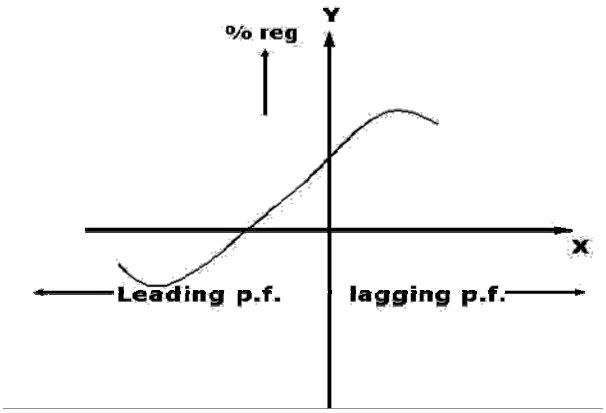
S.No	Load	Wcu (W)	O/P (W)	I/P (W)	η (%)
1					

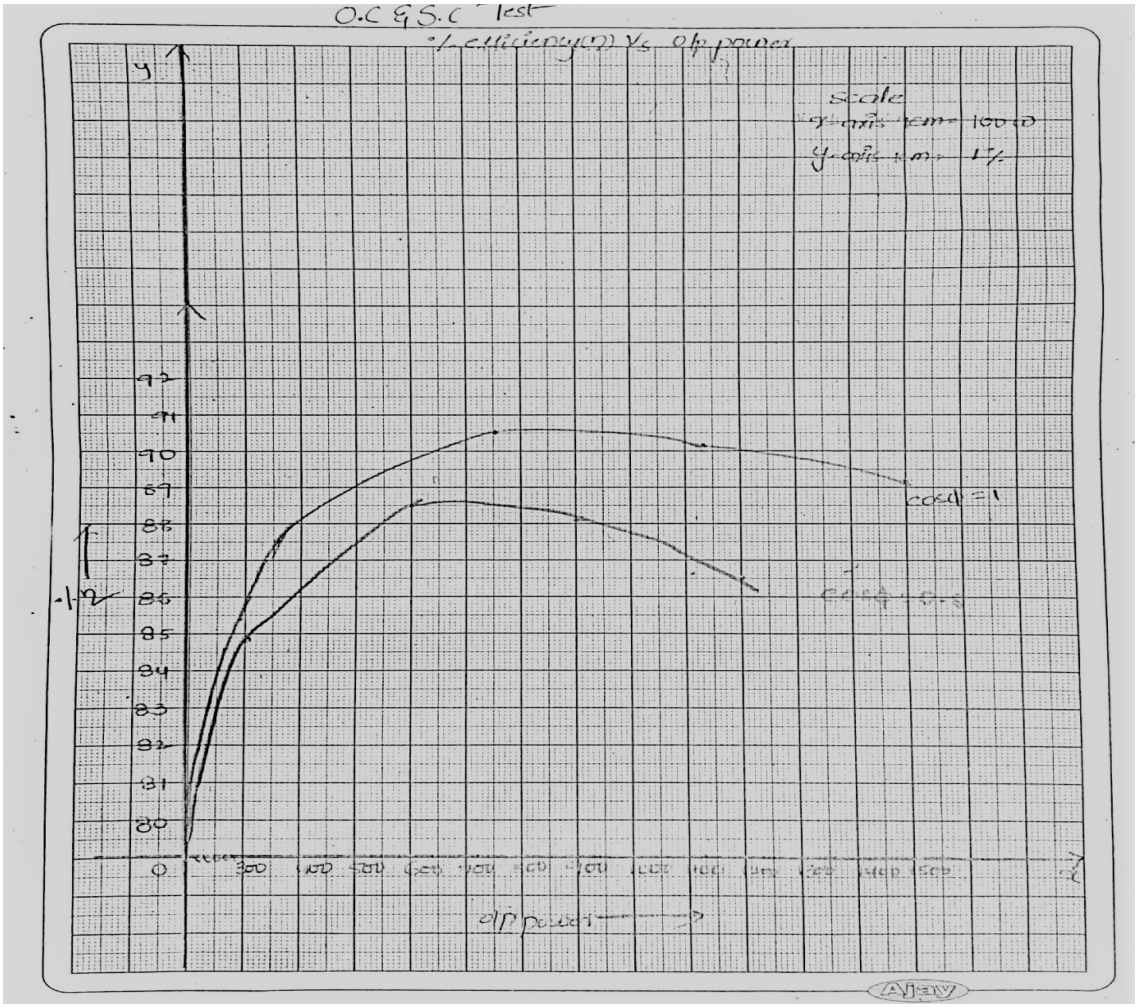
GRAPHS: Plots drawn between

1. % Efficiency Vs output



2. % Regulation Vs Power factor





PRECAUTIONS:

1. Connections must be made tight.
2. Before making or breaking the circuit, supply must be switched off.

RESULT: By conducting open circuit and short circuit test of a single phase transformer calculated the efficiency and regulation of the transformer.

8. SUMPNER'S TEST

AIM:

To determine the efficiency and losses of a given transformer accurately under full load condition.

APPARATUS REQUIRED:

S.NO.	NAME	RANGE	TYPE	QUANTITY
1	Voltmeters	(0-300)V (0-300)V (0-600)V	MI	1 NO 1 NO 1 NO
2	Ammeters	(0-2)A (0-20)A	MI	1 NO 1 NO
3	Wattmeter	(0-150)V LPF (0-2.5)A	Dynamo type	1 NO
4	Wattmeter	(0-150)V UPF (0-10)A	Dynamo type	1 NO
5	Connecting Wires	(0-20)A	-	Required

Transformer Specifications:

Two identical 1- ϕ Transformers

Transformer Rating :(in KVA) _____

Winding Details:

LV (in Volts): _____

LV side current:_____

HV (in Volts): _____

HV side Current:_____

Type(Shell/Core):_____

1 - ϕ Auto transformer Specifications:

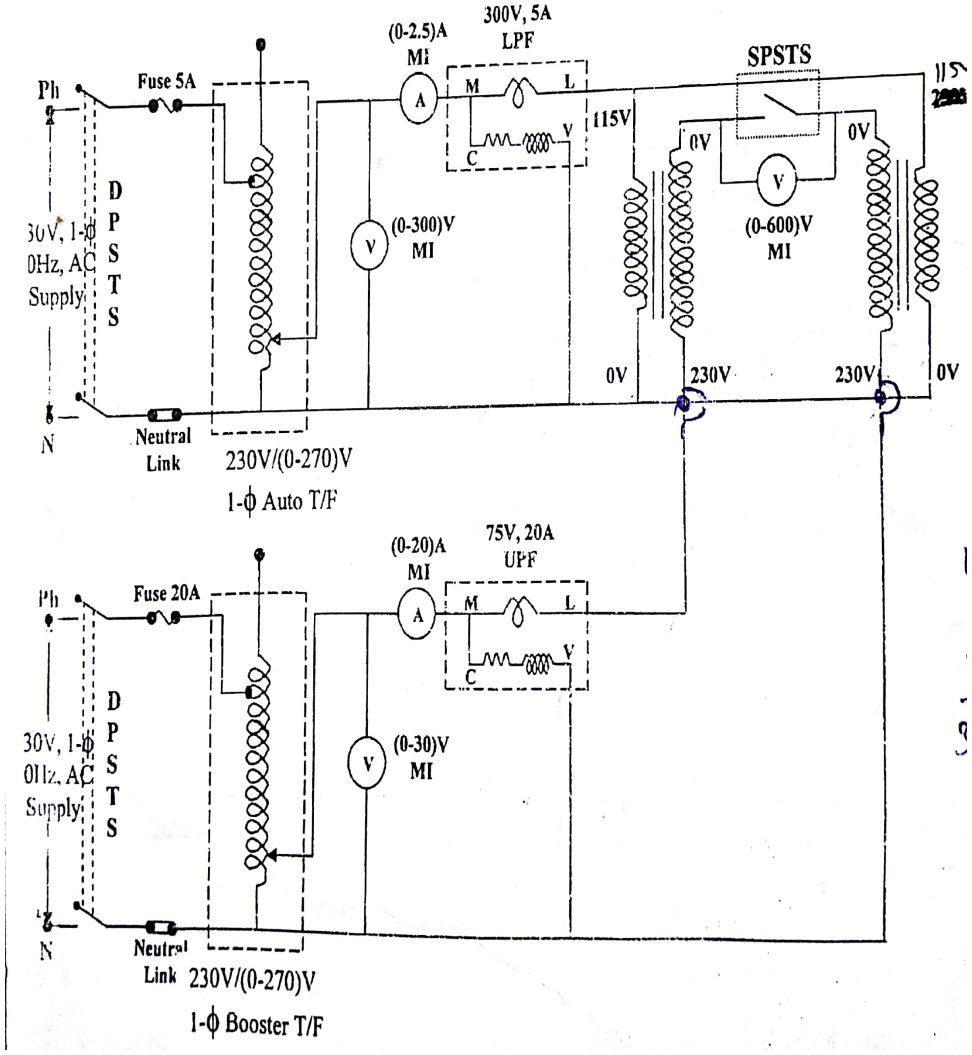
Input Voltage (in Volts):_____

Output Voltage (in Volts): _____

Frequency (in Hz):_____

Current rating (in Amp):_____

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the connections as per the circuit diagram.
2. The secondary winding terminals of the two transformers are connected in series with polarities in phase opposition which can checked by means of a voltmeter.
3. Before starting the experiment, check the variacs are in minimum output voltage position.
4. Close the first DPST-1 switch and switch ON the supply.

5. Increase the variac slowly, and apply rated voltage to the primary windings of 1-ϕ transformers and check the voltmeter reading connected across the secondary terminals.
6. If the voltmeter reading is Zero, continue with step 9.
7. If the voltmeter reading is not zero, interchange the secondary terminals.
8. Now close the DPST-2 switch and vary the variac-2 slowly till rated current flows in the two series-connected secondaries.
9. Note down the readings of V_1,V_2, I_1, I_2, W_1, and W_2 and enter them in a tabular column.
10. $W_1 = 2P_c$, $W_2 = 2P_{sc}$. Losses of each transformer = $(W_1+W_2)/2$ Now the Variacs are brought to zero voltage position and open DPST switches.

OBSERVATIONS:

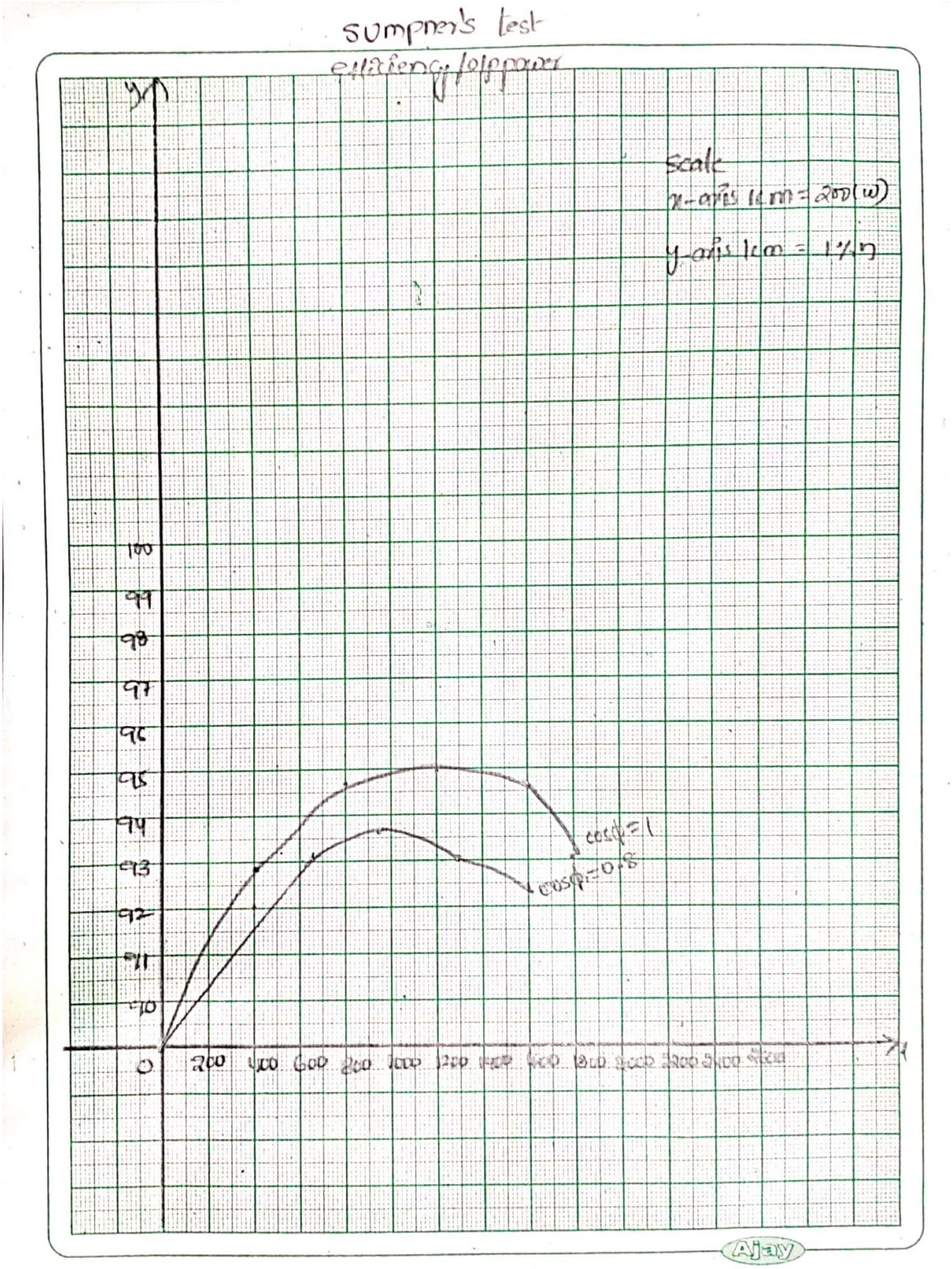
S.No	Voltmeter reading V_1	Voltmeter Reading V_2	Ammeter reading I_1	Ammeter Reading I_1	Wattmeter Reading W_1	Wattmeter Reading W_2	Transformer Losses = $(W_1+W_2)/2$	η = op/(op+loss)
1	115	34.36	1.2	8.6	28	100	128	68.98

Model Calculations:

Losses in each transformer=$(W_i+W_c)/2$

Combined Efficiency %η = $(VI_1)/(VI_1 +Wi+W_c)*100$

% η of each transformer = $(VI_1)/(VI_1 +Wi/2+W_c/2)*100$


sumpner's test
efficiency Vs output
Scale
x-axis 1cm = 200(w)
y-axis 1cm = 1%
100
99
98
97
96
95
94
93
92
91
90
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
cosφ=1
cosφ=0.8
Ajay

PRECAUTIONS:

1. Connections must be made tight.
2. Before making or breaking the circuit, supply must be switched off.

RESULT:

Efficiency of given Two transformers are found using Sumpner's test.

VIVA QUESTIONS:

1. What for this test is really intended?
2. Why to conduct the test on identical transformers?
3. What happens if the rated values of voltage and frequency of supply vary?
4. What are the advantages and disadvantages of this test?
5. Can you perform this test on 3 – Φ star/ delta transformers?
6. What is all-day efficiency?

9. LOAD TEST ON DC SERIES GENERATOR

Aim:-

To conduct load test on dc series generator and obtain external characteristics and internal characteristics

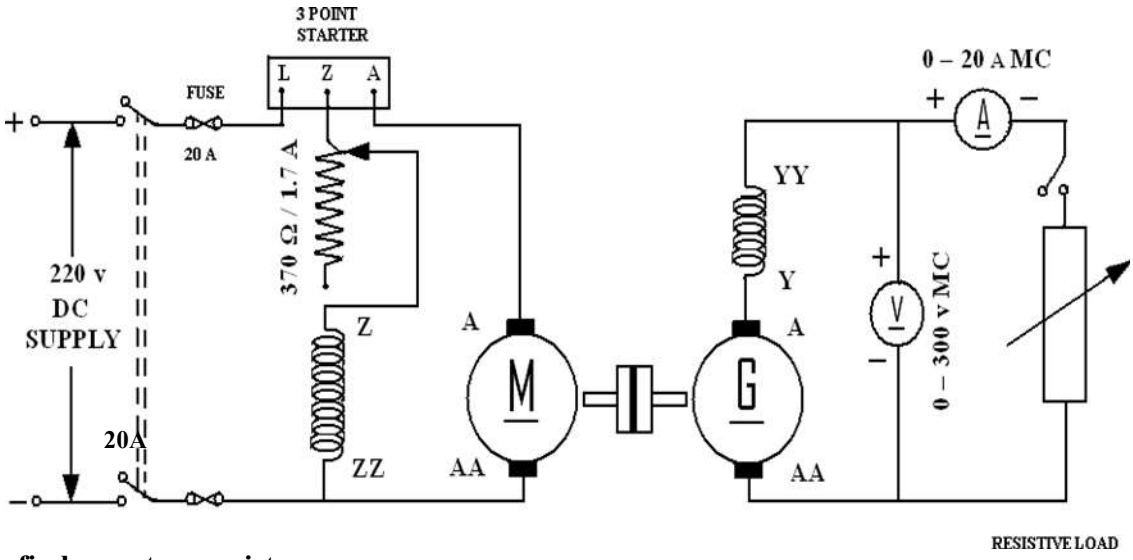
Apparatus Required:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-300)V	MC	2NO
2	Ammeter	(0-20)A	MC	1NO
3	Ammeter	(0-2)A	MC	1NO
4	Tachometer	(0-10,000) RPM	Digital	1NO
5	Rheostat	400Ω, 1.7A	Wire wound	1NO
6	Load box	230V,5KW/20A	Resistive	1NO
7	Connecting wires	(0-20)A	-	Required

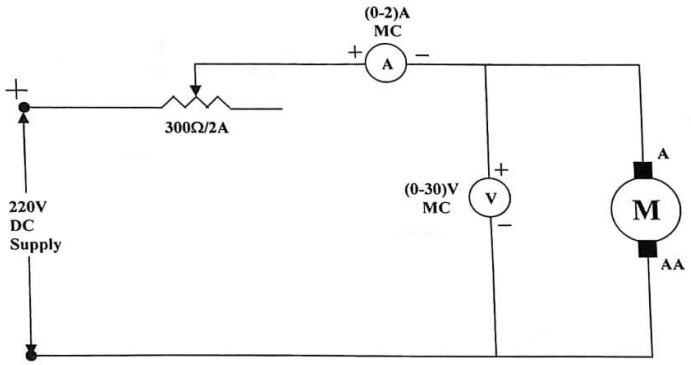
Nameplate details:-

Motor	**Generator**
Voltage - 220V	Voltage - 220V
Current -13.6A	Current -13.6A
Speed - 1500 rpm	Speed - 1300 rpm
Excitation type –series	Excitation type - series

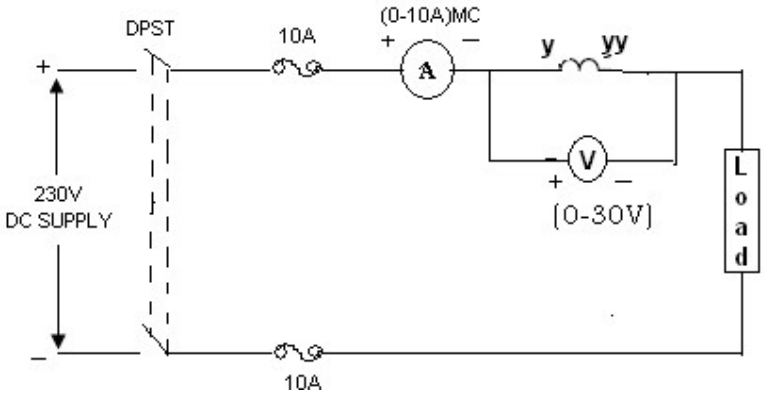
Circuit diagram:



To find armature resistance:-



To find series field resistance:-



Theory:- ----To be written---

Procedure:-

1. Make the connections as per the circuit diagram.
2. Ensure that series generator is electrically loaded to its rated capacity before giving supply and starting the machine.
3. Start the motor with the help of 2-point starter.
4. Decrease the resistive load in steps and note down the field current and terminal voltage.

To determine armature and field resistance:-

1. Connect the circuit as per the circuit diagram.
2 Switch on dc supply.
3. Increase the load and note down the voltage and current.

Tabular columns:-

Table1:

Field Current $I_f = I_L$ (amp)	Terminal Voltage (Volts)	$E_g = V + Ia(R_a + R_{se})$ (volts)
10	210	247
9	210	243.3
8	200	229.6
6	200	222.2
5	190	208.5

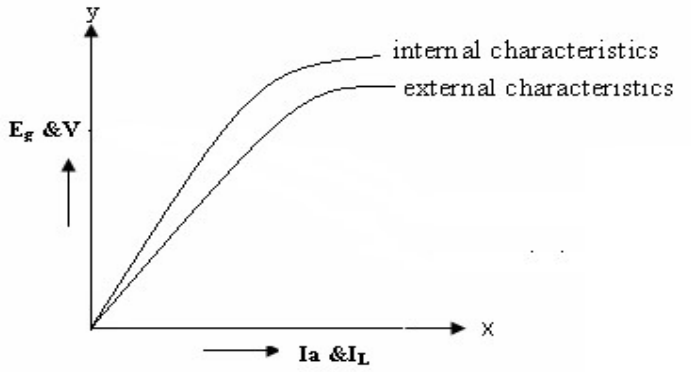
Table2: Armature Resistance

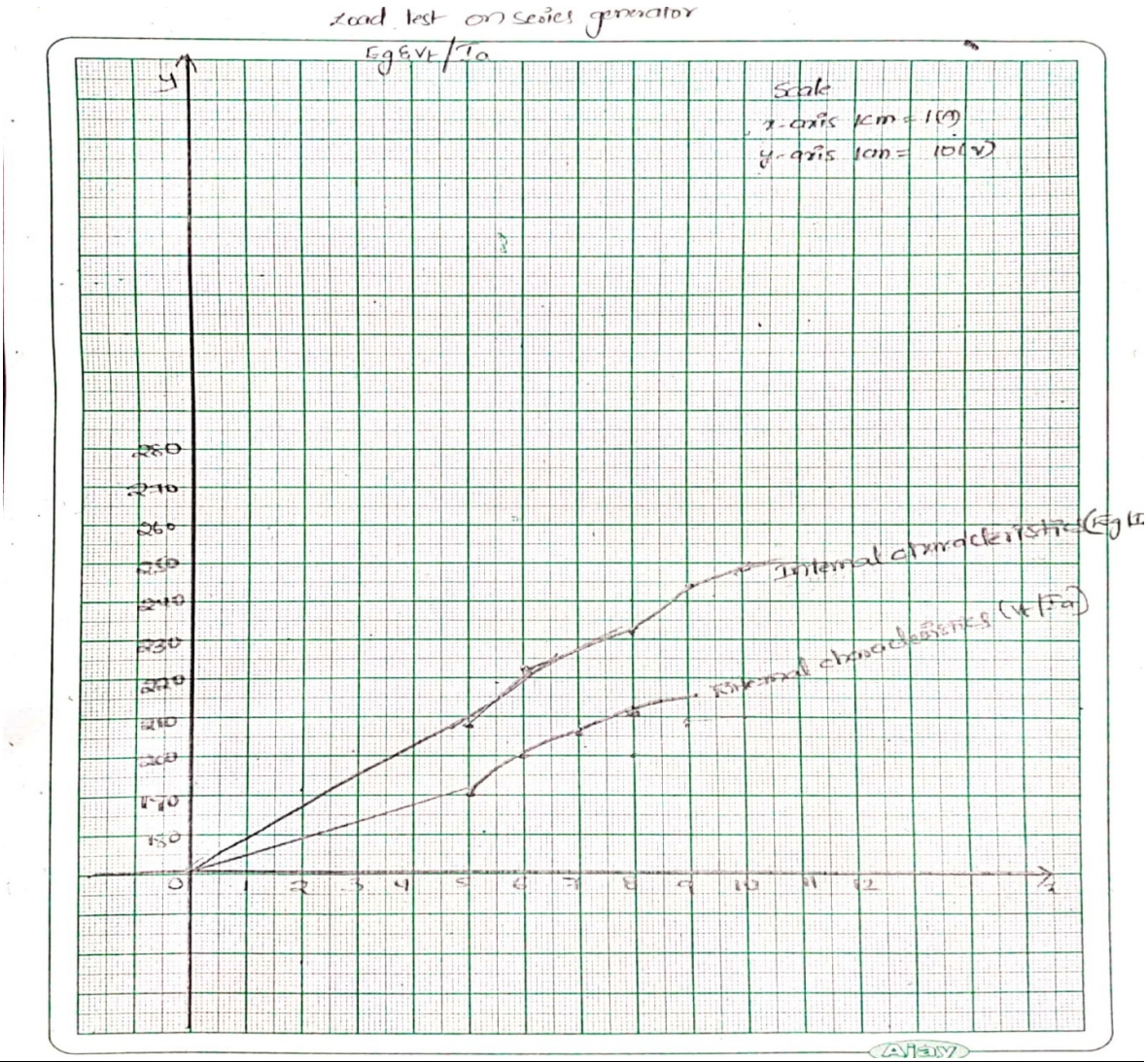
V(volts)	I(amp)	R_{se} =(V/I) (ohms)

Table3:Series field winding resistance

V(volts)	I(amp)	R_{se} =(V/I) (ohms)

Model graph:-


y
internal characteristics
external characteristics
E_g &V
x
Ia &I_L


Load test on series generator
Eg & Vt / Ia
y
Scale
x-axis 1cm = 1(A)
y-axis 1cm = 10(V)
Internal characteristics (Eg Ia)
External characteristics (Vt Ia)
0
x

Result:-

Internal and external characteristics of dc series generator are drawn by conducting load test on it.

Viva voce

1. What are the different types D.C.motors?
2. What is the necessity of starter?
3. What is the basic principle of motor?
4. Why the series motor has rising characteristics?
5. What are the applications of series generators?

10 .FIELD'S TEST ON DC SERIES MACHINES

Aim:-

To conduct field's test on a given two identical dc series machines and to determine the efficiency.

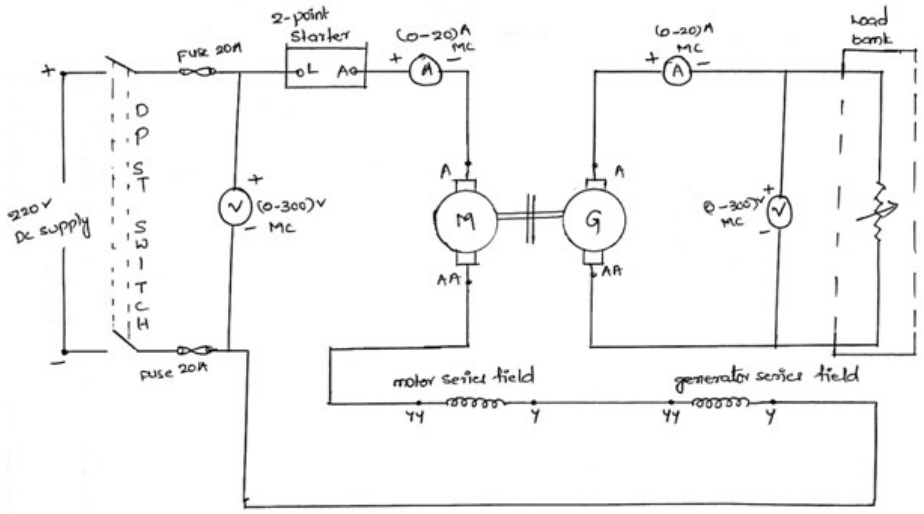
Apparatus:-

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-300)V	MC	2NO
2	Ammeter	(0-20)V	MC	1NO
3	Ammeter	(0-2)A	MC	1NO
4	Tachometer	(0-10,000) RPM	Digital	1NO
5	Rheostat	400Ω, 1.7A	Wire wound	1NO
6	Load box	230V,5KW/20A	Resistive	1NO
7	Connecting wires	(0-20)A	-	Required

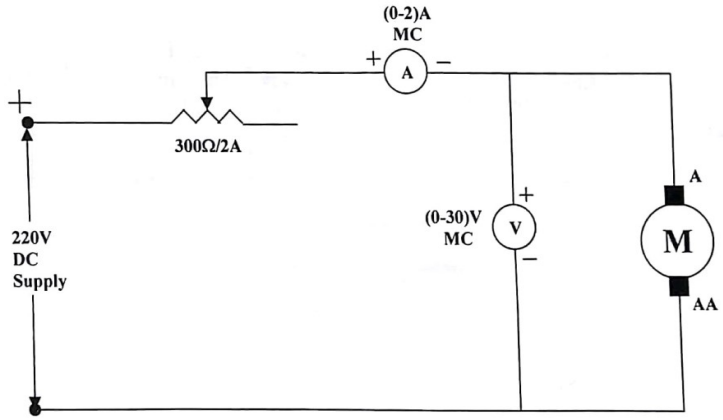
Nameplate details:-

Motor	Generator
Voltage - 220V	Voltage - 220V
Current -13.6A	Current -13.6A
Speed - 1500 rpm	Speed - 1300 rpm
Excitation type –series	Excitation type - series

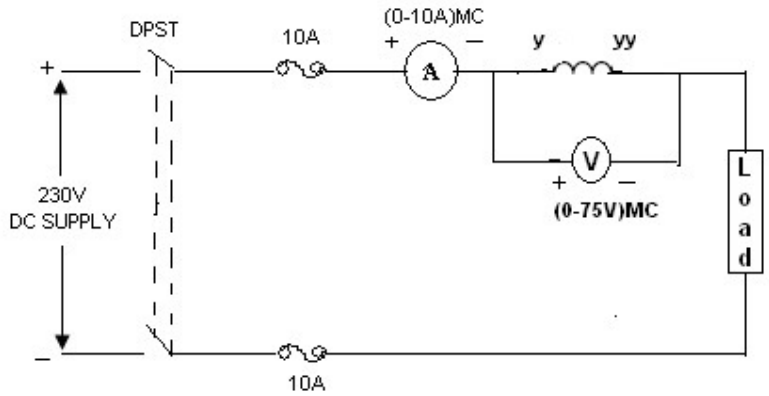
Circuit diagrams



To determine armature resistance:-



To determine series field winding resistance:-



Theory:- ----To be written---

Procedure:-

1. Connect the circuit as per the circuit diagram.
2. Ensure that dc series generator is electrically loaded to its rated current before starting.
3. Give the supply to the dc series motor by closing DPST switch and start the motor with the help of 2- point starter.
4. Note down the readings of voltage across armature and series field winding of dc series generator and terminal voltage across the load of dc series generator.
5. Repeat step no:4, by decreasing electrical load till 30% of rated current is obtained.
6. Switch off the supply by opening DPST switch.

To determine armature resistance:-

1. Connect the circuit as per the circuit diagram.

2. Switch on dc supply.

3. Increase the load and note down the voltage and current.

To determine series field winding resistance:-

1**.** Connect the circuit as per the circuit diagram.

2. Switch on dc supply.

3. Increase the load and note down the voltage and curren

Table:1

s.no	Input Voltage V (volts)	Armature current of motor I_1 (amps)	Armature current of generator I_2 (amps)	Motor voltage V_1(volts)	Generator voltage V_2 (volts)	Input power $W_i = V*I_1$ (watts)	Armature cu losses of motor $W_{cu,m} = (I_1)^2*R_a$ (watts)	Armature cu losses of generator $W_{cu,g} = (I_1)^2*R_a$ (watts)	Motor field cu losses $W_{se,m} = (I_1)^2*R_{se}$ (watts)
1	220	3.5	4	220	90	770	23.27	30.4	22.05
2	220	4	4.5	220	80	880	30.4	38.475	28.8
3	220	4	5	220	80	880	30.4	47.5	28.8
4	220	4.5	5.5	220	80	990	38.4	57.47	36.45
5	220	5	6	220	75	1100	47.5	68.4	45

Generator field cu losses $W_{se,g} = (I_1)^2 * R_{se}$ (watts)	Stray losses $Ws = W_i - \{W_{cu,m} + W_{cu,g} + W_{se,g} + W_{se,m}\}$ (Watts)	Total losses of motor $W_m = W_{cu,m} + W_{se,m} + Ws/2$ (Watts)	Total losses of generator $W_g = W_{cu,g} + W_{se,g} + Ws/2$ (Watts)	% efficiency of motor $\%\eta_m = \frac{V_1 I_1 - W_m}{V_1 I_1} * 100$	% efficiency of generator $\%\eta_g = \frac{V_2 I_2}{V_2 I_2 + W_g} * 100$
22.05	672.225	381.44	388.56	50.46	46.09
28.8	753.2	435.96	444.04	50.45	44.8
28.8	744.5	431.45	448.55	50.97	47.14
36.45	821.5	504.5	504.5	49.04	46.6
45	894.1	521.97	560.45	52.55	44.53

Table:2

Armature Resistance

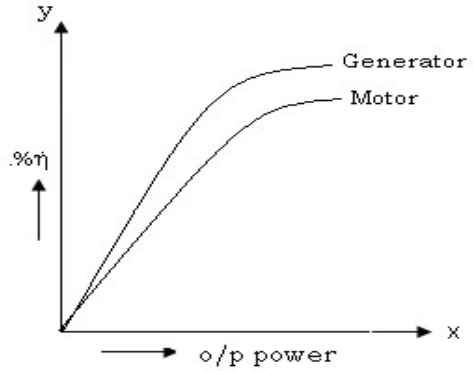
V	I	R_a =(V/I)

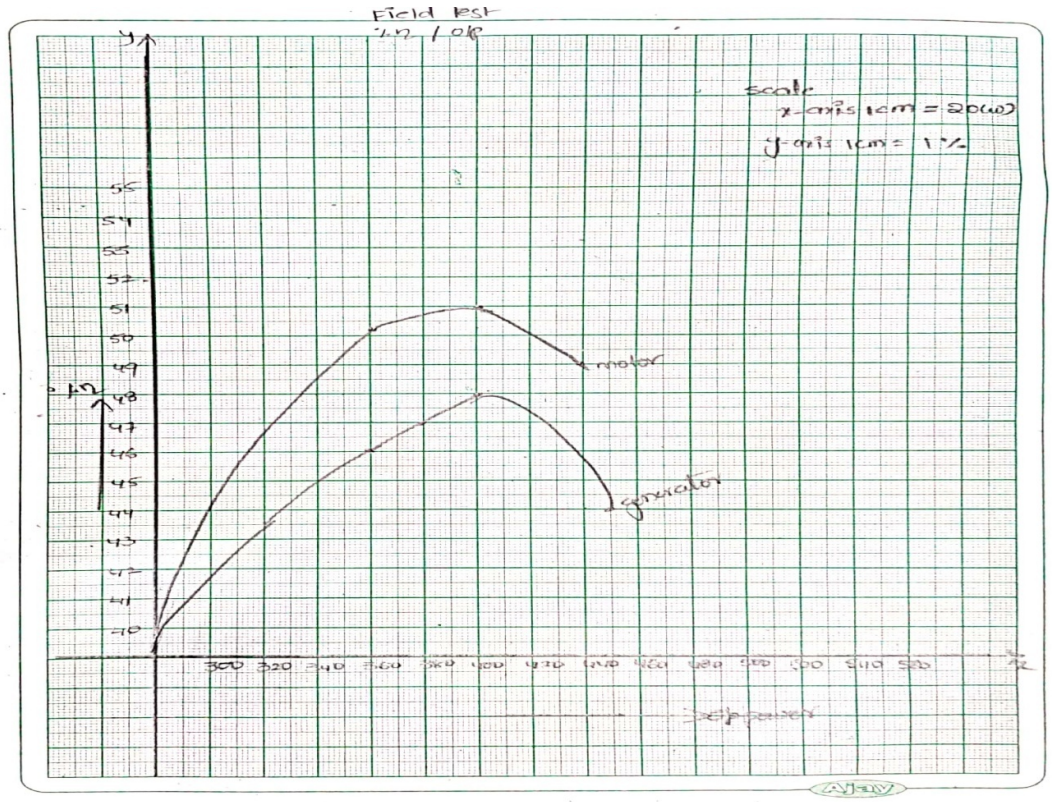
Table:3

Series field winding resistance

V	I	R_a =(V/I)

MODEL GRAPH:-





Calculations:-

Input voltage V=___ volts

Voltage across series field and armature winding V_1 =____ volts

Armature current of dc series motor, I_1 =____amps

Armature current of dc series generator I_2 =____amps

Terminal voltage of dc series generator V_2 =____ volts

Input power to the set $W_i = V * I_1$ watts

Armature copper losses of motor $W_{cu,m} = (I_2)^2 * R_a$ watts

$W_{cu,m}$ = _____ watts

Armature copper losses of generator $W_{cu,g} = (I_1)^2 * R_a$ watts

$W_{cu,g}$ =_____watts

Generator field copper losses $W_{se,g} = (I_1)^2 * R_{se}$ watts

$W_{se,g}$ = _____ watts

Motor field copper losses $W_{se,m} = (I_1)^2 * R_{se}$ watts

$W_{se,m}$ = _____ watts

Stray losses $Ws = W_i - \{ W_{cu,m} + W_{cu,g} + W_{se,g} + W_{se,m} \}$ Watts

Total losses of motor $W_m = W_{cu,m} + W_{se,m} + Ws/2$ Watts

Total losses of generator $W_g = W_{cu,g} + W_{se,g} + Ws/2$ Watts

Percentage efficiency of motor $\%\eta_m = ((V_1 I_1 - W_m)/ V_1 I_1) * 100$

Percentage efficiency of generator $\%\eta_g = ((V_2 I_2)/ (V_2 I_2 + W_g) * 100$

Result:-

Field test is conducted on a given dc series machine and hence efficiency is calculated for motor and generator .

Viva voce

1. Why we are always start the series motor on load only?
2. Give me one application of the series motor?
3. What is the relation between torque and load current?
4. What is the necessity of doing fields test?

11. POLARITY TEST ON A 1-PHASE TRASFORMER

Aim:

To conduct the polarity test on a 1-phase transformer

Apparatus:

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-30)V	MI	1NO
2	Ammeter	(0-10)A	MI	1NO
3	1-Phases Transformer	2 KVA, 115/230	-	1NO
4	Connecting wires	(0-20)A	-	

Name plate details:

Transformer Specifications:

Transformer Rating :(in KVA) _____

Winding Details:

LV (in Volts): _____

LV side current:_____

HV (in Volts): _____

HV side Current:_____

Type (Shell/Core):_____

Auto transformer Specifications:

Input Voltage (in Volts):_____

Output Voltage (in Volts): _____

frequency (in Hz):_____

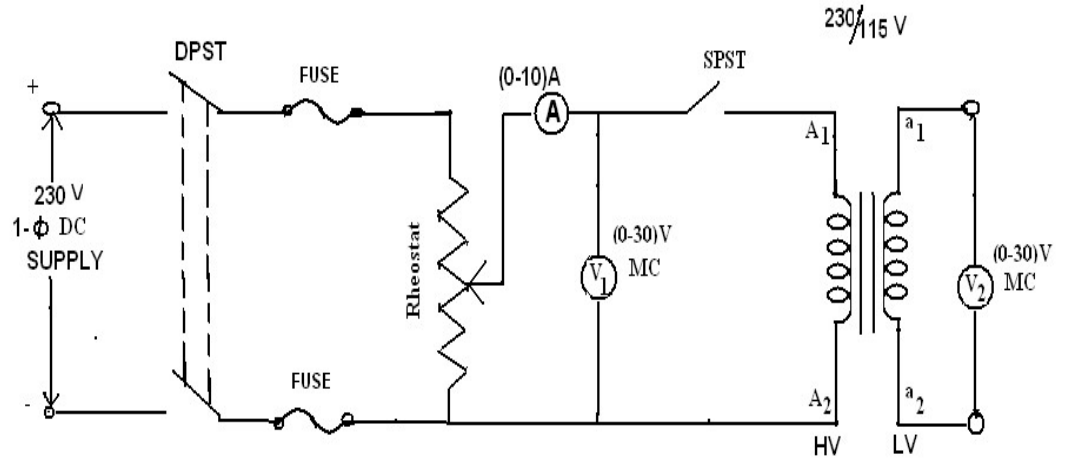
Current rating (in Amp):_____

Theory:

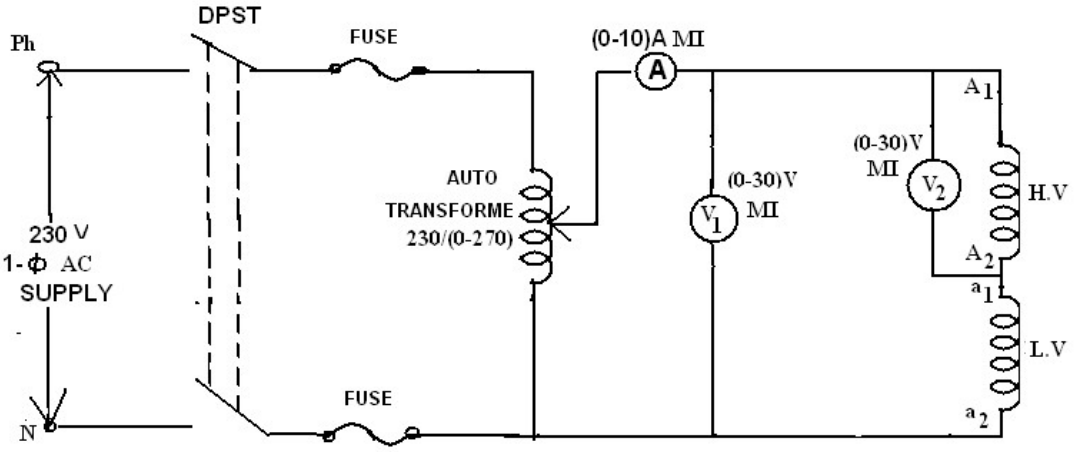
----To be written---

Circuit diagram:

A) For D.C Supply:



B) For A.C Supply:



Procedure:

For D.C. Supply:

1. Make the connection as per circuit diagram
2. By varying the potential divider set the input voltage to 10 V.
3. Close the SPST switch and observe the deflection in voltmeter V_2
4. If the direction of pointer in V_2 is positive then A_1 is positive with respective A_2 and also a_1 is positive with respective a_2.
5. If the direction of pointer in V_2 is negative then change the polarity on either side.

For A.C. Supply:

1. Make the connections as per the circuit diagram.
2. Apply 20V, by varying auto transformer.
3. Observer V_1 & V_2.
4. If V_2 is less than V_1 then assumed polarity in circuit1 is correct otherwise polarity is opposite.

Result:

For given transformer polarity test is performed.